Southern

Sky and TELESCOPE

Copyright, 1945, by
Sky Publishing Corporation

CHARLES A. FEDERER, JR., *Editor* HELEN S. FEDERER, *Managing Editor*

EDITORIAL ADVISORY BOARD: **Clement S. Brainin**, Amateur Astronomers Association, New York; **Edward A. Halbach**, Milwaukee Astronomical Society; **Donald H. Menzel**, Harvard College Observatory; **Paul W. Merrill**, Mt. Wilson Observatory; **Oscar E. Monnig**, Texas Observers; **Henry Norris Russell**, Princeton University Observatory; **Charles H. Smiley**, Ladd Observatory; **Percy W. Witherell**, Bond Astronomical Club.

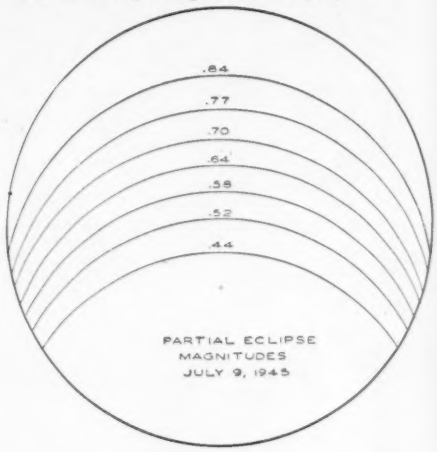
The Editors Note . . .

ON July 9th, millions of persons will probably rise early to view the eclipse of the sun, but only thousands will be where they may experience the rare thrill and beauty of totality. Nevertheless, the partial phase is of considerable interest, and the **Eclipse Supplement** to the **American Ephemeris** gives useful information for numerous points in the United States and Canada.

This partial eclipse data includes the times of beginning, middle, and ending of the partial phase, also the position angles of the first and last contacts. The magnitude of mid-eclipse is given, and defined as the fraction of the sun's diameter covered by the moon. Each circle on the accompanying diagram represents the moon when it has covered the fraction of the sun's diameter marked (position angle has been ignored), and these circles correspond exactly or nearly with maximum eclipse at the following places:

Denver, Minneapolis, .84; Des Moines, Madison, Santa Fe, .77; Juneau, .72; Ann Arbor, Springfield, Ill., .70; Cincinnati, Columbus, Syracuse, .64; Pittsburgh, .63; Charleston, W. Va., Oxford, Miss., .59; Austin, Tex., Cambridge, Mass., New Haven, .58; New York, Philadelphia, .57; Atlanta, Baton Rouge, .52; Tallahassee, .44.

Maximum obscuration at other places may be approximated by drawing uniform and parallel curves on a United States map through points of equal obscuration, and interpolating for the points desired. Such a chart appears in the **Eclipse Supplement,** and the United States portion was reproduced in **Sky and Telescope,** April, 1945, page 11.



VOL. IV, NO. 8
Whole Number 44

JUNE, 1945

CONTENTS

COVER: A group of elementary school children in Glencoe, Ill., under the direction of John Sternig, observe the sun by means of the projection of its image on a white card. This is the safest way to view the sun, and allows many to observe the sunspots at once. (See page 3 and page 12.)

THE SUN AND ECLIPSES—Marian Lockwood 3
ANTIQUE ORRERY—Francis P. Witmer 6
ECLIPSE CHATTER 8
THE MYSTERIOUS BLAST OF MAY FOURTH 10
ELEMENTARY SCHOOL ASTRONOMY—John Sternig 12

Amateur Astronomers	5	News Notes	9
Astronomical Anecdotes	11	Observer's Page	16
Books and the Sky	14	Planetarium Notes	17
Gleanings for A.T.M.s	20	Southern Star Chart	19
		Stars for June	18

BACK COVER: Photograph of a large sunspot group near the center of the sun's disk, taken by Philip C. Keenan, July 10, 1937, with the 40-inch refractor at Yerkes Observatory. Various portions of the picture show the solar granules or "rice-grains" very well, whereas other parts are blurred by convection currents in the earth's atmosphere.

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $2.50 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.00; all other foreign countries, $3.50. Make checks and money orders payable to Sky Publishing Corporation. Send notice of change of address 10 days in advance. Circulation manager: Betty G. Dodd.

Editorial and general offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we do not guarantee prompt editorial attention under present conditions, nor are we responsible for the return of unsolicited manuscripts unless adequate return postage is provided by the author.

Advertising director: Fred B. Trimm, 19 East 48th Street, New York 17, N. Y.; ELdorado 5-5750.

THE SUN AND ECLIPSES

By MARIAN LOCKWOOD

Interest in the sun, sunspots, and eclipses, discussed here and in the Hayden Planetarium this month, is heightened by the approaching eclipse of July 9th, which will be seen as partial in most of the United States and Canada.

Give me the silent sun, with all his beams full-dazzling.

WALT WHITMAN

On April 7, 1940, the Rev. Wm. M. Kearons photographed the partial eclipse—note the small sunspot.

THAT the sun is the source of the energy which sustains life upon our earth has been realized from earliest times. It is fairly obvious that not only direct energy in the form of heat and light comes from the sun, but also energy derived indirectly, such as that provided by food and fuel. A world without the beautiful and invigorating light and heat of the sun woud be an unthinkable place. Long periods of cloudy and rainy weather are lived through in the certain knowledge that the sun will "come out" again and that once more birds will sing in the sunny green of trees, white clouds will float through bright blue skies.

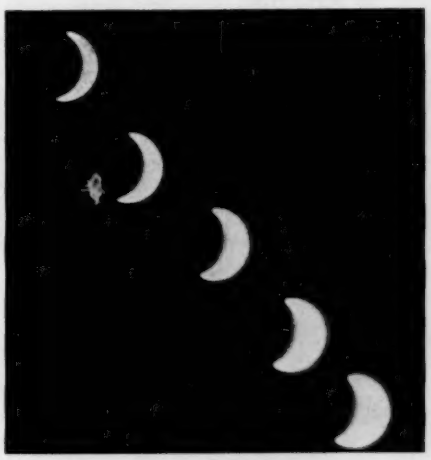
As a result of the realization of the essential part played by the sun in our lives, men have from ancient times feared a blacking-out of the sun, perhaps more than any other natural phenomenon. It is only in comparatively recent times that we have come to understand that eclipses do not mean the end of the world, and that few scientific events can vie with them in interest and beauty.

The subject of eclipses is of special interest at the present time because on July 9th of this year the dark, solid body of the moon is scheduled to come directly between the earth and the sun, cutting off all of the sun's direct light from certain parts of the earth's surface. Even though this eclipse is to be total in a very small area of the United States, and only partial over most of the country, it is still a matter of great interest astronomically, and many millions of people will be watching it. In order to visualize what is to happen, the relationship between earth, sun, and moon must be clearly understood.

Although the sun is 864,000 miles in diameter and the moon only 2,160, the two bodies appear to us on the earth as of about the same size. This is true because, while the sun is about 400 times the diameter of the moon, it is also about 400 times as far away.

During any lunar month, a period of time which does not of course correspond exactly to our calendar month, the moon travels entirely around the earth from west to east, changing its phases constantly as its position relative to sun and earth changes. When the moon comes almost between us and the sun, we cannot see it because then the illuminated side is turned away from us, and furthermore, at such times the moon sets with the sun and rises with it. The moon has no light of its own, but shines as do the planets and the 27 other moons of the solar system, by reflected sunlight.

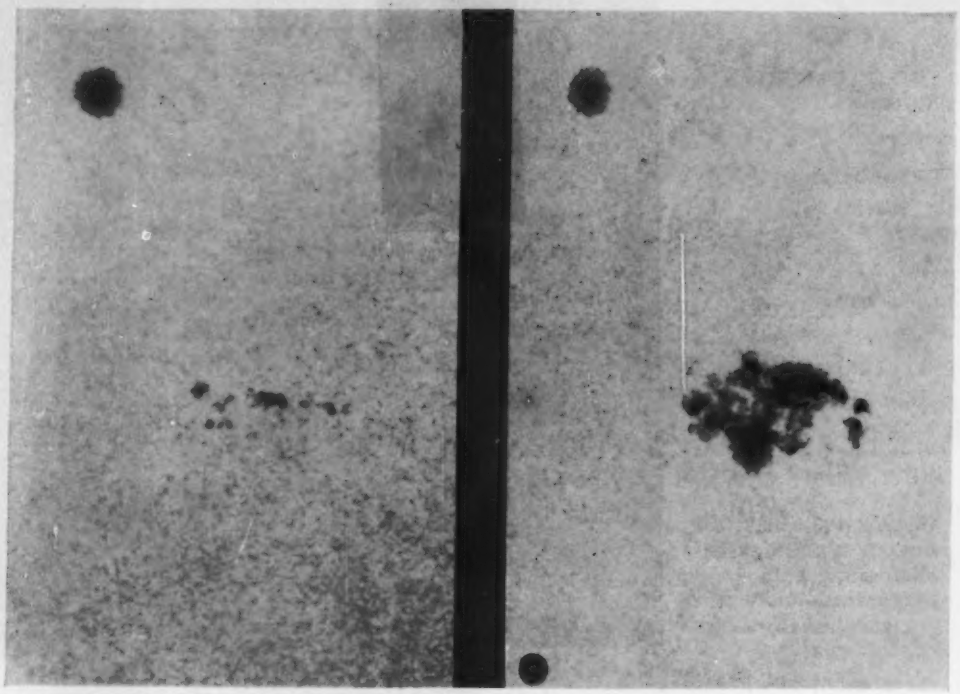
Ordinarily, when the moon passes between the earth and the sun, the three bodies are not exactly in a straight line, for the plane of the moon's path around the earth is inclined to the plane of the earth's path around the sun by about five degrees. This leaves the moon at dark of the moon (new moon) usually either above or below the sun in the sky.



At the eclipse of August 31, 1932, at Fryeburg, Me., Claude Pendill photographed the partial phases on 16 mm. film, from which these enlargements were made. (See page 5.)

When, however, as sometimes happens, the earth, moon, and sun are almost exactly in a straight line, the moon comes directly between us and the sun, and a total eclipse occurs, varying with the conditions from a few seconds to as much as 7½ minutes of totality. The eclipse of July 9th will be total as seen from a narrow path extending through Idaho and Montana, and on through Canada, Greenland, Norway, Sweden, and Siberia. From the rest of the United States, the eclipse will be seen as partial, only a part of the sun's surface being covered (see page 3). Near New York City, the eclipse will be 57 per cent total; about half the sun's surface will be covered up. While an eclipse of this magnitude will not perceptibly affect the amount of sunlight, it will be an interesting event to watch, as the dark limb of the moon slides gradually across the sun's surface. Observers are cautioned most earnestly, however, not to watch the eclipse without some adequate viewing device such as heavily exposed film or very opaque smoked glass. Great damage can be done to the eyes by neglecting this warning. And never, under any circumstances, should the sun be observed *at any time* directly through opera glasses, binoculars, or a telescope, without a solar eyepiece. Project the solar image onto a white surface, and you can observe with perfect safety, as shown on the front cover this month.

A total eclipse of the sun occurs



Photographs taken at Mount Wilson Observatory show the 24-hour development of a sunspot group. The spot in the upper left has remained almost unchanged, however. The black spot at the bottom represents the earth on the same scale.

only when the moon's disk is centered against that of the sun *and* when the distance of the moon from the earth is such that the moon appears larger than the sun in the sky. The moon's distance from the earth varies considerably, from less than 222,000 miles to nearly 253,000 miles. Because of this variation in distance, the moon sometimes appears larger than it does at other times. When the moon is at its least distance from the earth, it naturally appears largest to us. Under such circumstances, with the earth, moon, and sun in a straight line, we observe a total eclipse of considerable duration. If the moon's disk is centered against the sun when the moon is near its greatest distance from the earth, then the moon does not seem quite large enough to cover up the sun, and there is a ring of light around the outside of the moon. This is known as an annular eclipse, and is a special kind of partial eclipse. An ordinary partial eclipse occurs when the moon is not centered against the sun as seen from any place on the earth.

On July 9th, those who travel to the belt of totality will see the beautiful corona, Baily's beads, and the impressive darkening of the sky which is an accompaniment of a total eclipse. Conditions on this continent, however, will not be perfect, for the eclipse occurs very near the time of sunrise, and there is danger of the sun's being obscured by the mists which are likely to hover in the early morning and appear thickest near the horizon.

While a total eclipse is the most spectacular phenomenon connected with the sun, astronomers have for many centuries been especially interested in the dark areas which appear frequently on the solar surface. These are known as sunspots, a modest name which hardly gives an adequate idea of the vast importance and reach of these cyclonic areas.

Before the beginning of our era, Chinese astronomers noticed the presence of dark spots on the sun's surface and recorded minutely careful descriptions of their appearance. Those particular sunspots must indeed have been large since the Chinese had no telescopes and observed them with the naked eye. Galileo, using almost for the first time his new and exciting "optick tube," examined them with the greatest interest, at first believing these spots to be "solar clouds," or possibly hitherto unknown planetary bodies.

Sunspots are known now to be vortices or electromagnetic disturbances in the hot, gaseous body of the sun. Another way of putting it is to describe them as areas of storm in the photosphere or light sphere, which is the part of the sun ordinarily visible to us. There is a great range in the size of the spots, and undoubtedly there are many which are too tiny to be seen. On the other hand, groups of spots with diameters up to 100,000 miles have been photographed. Typical sunspots are dark in the center—this part is called the umbra—and may have diameters of 20,000 miles or more. A lightly shaded section around the umbra is known as the penumbra.

When Galileo observed these spots so many centuries ago, he probably had no conception of the fact that they could have any connection with our life here upon the earth. Today, however, we realize that not only is the sun the source of energy upon the earth, but that storms which occur on its surface influence our daily life in many ways. We are just beginning to understand some of these effects which we experience in the form of magnetic storms, weather of all kinds, and such beautiful apparitions in our sky as the auroral lights.

From regions on the sun associated with sunspot vortices, electrically charged particles stream out, many of them moving in the direction of the earth. These electrified particles act on the rarefied gases in the earth's upper atmosphere, causing these gases to glow with color and light, producing the aurora. Magnetic storms, which often cause considerable damage to all kinds of communications systems upon the earth, can also be traced back to the effect of solar emanations. But most important of all, perhaps, is the relationship between sunspots and terrestrial weather.

It is known that sunspots occur in cycles averaging 11.2 years from one maximum to the next. Rainfall has been discovered to occur in a similar cyclic period, and it is now established almost without question that the two are closely correlated. Much of the original work done on this problem was carried on by Dr. A. E. Douglass, of the University of Arizona, who established the rainfall cycle by an extensive and close examination of tree rings. In the years when rainfall is greatest, the annual tree rings show maximum width.

To us the sun appears a spectacularly beautiful and brilliant object, and, because of this, through the ages it has stood as a symbol for all that is bright and clear and life-giving. Actually, if observed at the average distance of the stars which we see in the night sky, it would appear insignificant and dim. However, the sun is *our* star, and wherever it travels, you and I must follow. With reference to nearby stars, we are headed toward a point in the constellation Hercules, traveling along with the sun at the rate of about 12 miles a second. As the sun speeds along, its whole family journeys with it—planets, satellites, comets, meteors,

(Continued on page 10)

Amateur Astronomers

ECLIPSE PHENOMENA REVIEWED

A RECENT meeting of the Detroit Astronomical Society was devoted to a symposium on "Work for Amateurs during a Total Solar Eclipse." Five speakers took part, among them Professor W. Carl Rufus, of the University of Michigan, who had an observing outline prepared which gave a vivid description of the order of the phenomena accompanying an eclipse. With his permission, we reproduce the essential parts of this outline, which graphically opens: "Camp Cheerio. Up at sunrise. Clear and fair. Canadian bacon, coffee, and toast. All eyes to the east."

Previous Preparations (using available data from the **Ephemeris Supplement** and other sources) include selection of a site, determination of its latitude and longitude; times of the four contacts from that station (first, beginning of partial; second, beginning of totality; third, end of totality; fourth, end of partial); duration of totality; time of mid-eclipse, and altitude and azimuth of the sun at that time; assembling of equipment, telescopes, binoculars, stop watches, cameras, thermometers, smoked glass, radio for time signals and to test reception, a small direct-vision spectroscope for the flash spectrum, a chart showing the position of sun, bright stars, and planets.

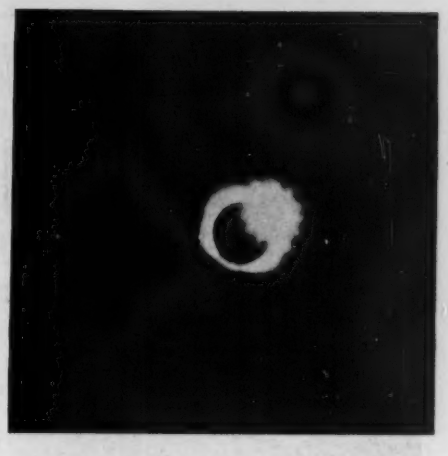
Proposals for Observation: First Contact. Time, position on sun. Note progress of partial phase, perhaps photographically. Passage of limb of moon over sunspots; contrast dark color of moon and spot; note apparent change of color of spot. Shape of sun's image under trees or projected through pinhole. Color effects, grass, foliage, landscape, countenances. Temperature; radio reception; effect on animals. Do any stars or planets appear?

Near Totality. Swift approach of shadow from southwest. Shadow bands, on ground or wall (white sheet), their distance apart, direction, velocity. Decreasing crescent of sun, pulsations or unsteadiness, color of tips of crescent. Baily's beads usually seen, and parhelia and rays, occasionally.

Second Contact. First appearance of corona, which side? Flash spectrum, change from dark lines to bright (this marks the instant of second contact). Chromosphere and prominences, color and form. Corona, inner detail, color; outer form, polar rays, filaments, streamers; general form and extent of corona; relation to spots and prominences, if any. Total brightness of eclipsed sun. Visibility of stars and planets, what limiting magnitude? Terrestrial conditions, temperature, radio, degree of darkness, distance of visible objects, color effects.

Third and Fourth Contacts. Time. Other phenomena in reverse order to that of second and first contacts.

It is apparent that no one person would have time to make accurate observations of all these phenomena, but this outline should serve to help amateurs set up and rehearse an observing program, simple or elaborate, for the fleeting minutes and seconds of the actual event.



The diamond ring at the 1932 eclipse, enlarged from one of Claude Pendill's 16 mm. films. **(See page 3.)**

SPECIAL ACTIVITIES

Cincinnati: Saturday, June 16th, is Observatory Night for the Cincinnati Astronomical Society, featuring use of the 8-inch refractor at the society's observatory. This is reached via Zion Road, two miles north from the Cincinnati-Louisville Pike.

New Haven: The New Haven Amateur Astronomical Association has scheduled for its meeting on Saturday, June 13th. Ivan Gibson will Inspection and Picnic, at the home of Mr. Broacher, Nichols, Conn.

ASTRONOMY IN WINDSOR

Near the close of 1944, a new centre was added to the 10 already belonging to the Royal Astronomical Society of Canada. This new Windsor Centre began life in October, 1943, as the Astronomy Study Club of Windsor. As of April, this year, Windsor had 37 paid-up members. President of the centre is C. H. Montrose, of 1758 Dacotah Drive, 3-5447.

At its meeting on Tuesday, June 5th, at 8:00 p.m., in the Willistead Library, the Windsor group will hear Cyril Hallam speak on "Solar Eclipses," and Hugh Murray, on "Events of the Summer." The public is invited to attend without charge.

CLEVELAND PUBLIC NIGHTS

"The Milky Way" will be the subject of talks on June 21st and 22nd at the Warner and Swasey Observatory. The lectures start at 8 o'clock, and observing through the telescope follows each evening's lecture. Reservations for these public nights may be made through the Case School of Applied Science, GArfield 6680.

ASTRONOMY SCHOOL

Boy Scouts and C. M. Cannaday and others of the Indiana Astronomical Society began, on May 8th, an astronomy school which anyone interested in astronomy might attend. There is no expense except for astronomy aids at from 1c to 25c. The Boy Scouts are studying for the Merit Badge in astronomy. The school is held at the Utley Hut Boy Scout Building, 3729 Boulevard Place, Indianapolis, Ind.

THIS MONTH'S LECTURES

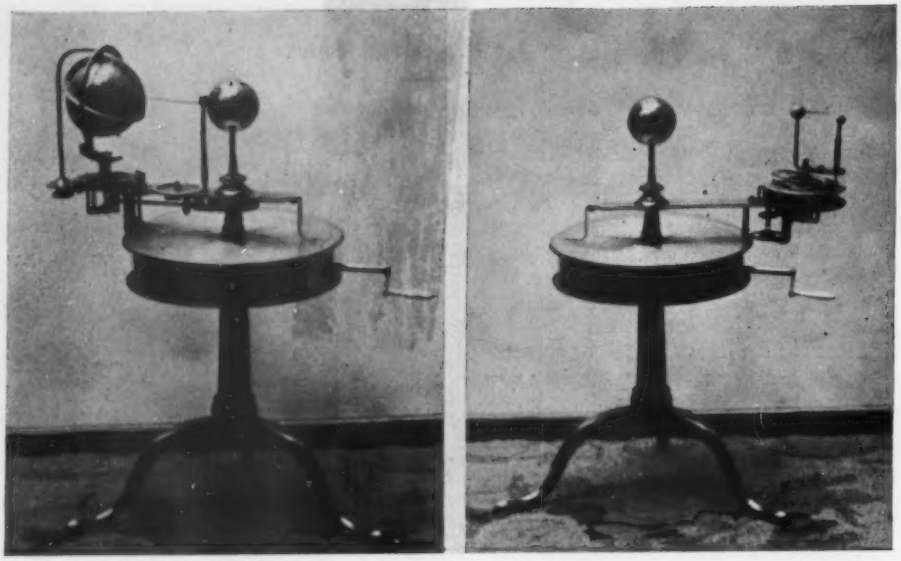
Boston: "A Year of Astronomical Progress" will be the subject of the talk by Dr. Bart J. Bok, of Harvard College Observatory, to the Amateur Telescope Makers of Boston, on Thursday, June 14th, 8:00 p.m., at the Harvard Observatory, Cambridge.

Chicago: An illustrated lecture on "Eclipses of the Sun and Moon" will be presented to the Burnham Astronomical Society by Thomas J. Bartlett, Dearborn Observatory, Northwestern University, at their meeting on Tuesday, June 12th. Preceding this, one of the society's members, Frank G. Callander, will speak on the June evening sky. The group will meet at 8:00 p.m. in the Chicago Academy of Sciences auditorium.

Detroit: Professor Everett R. Phelps, of Wayne University, will speak to the Detroit Astronomical Society "Concerning Meteors and Meteorites," on Sunday, June 10th, 3:00 p.m., at Wayne University.

Indianapolis: "Summer Skies" will be the subject of the talk by Victor Maier at the meeting of the Indiana Astronomical Society on Sunday, June 3rd, at 2:15 p.m. in Odeon Hall.

Madison: "A Trip to the Sun" will be described before the Madison Astronomical Society on Wednesday, June 13th. Ivan Gibson will be the speaker. Election of officers and an astronomical quiz are also scheduled for this meeting.



The tellurion arrangement is shown at the left, the lunarium at the right.

Antique Orrery

By Francis P. Witmer

THE WRITER is fortunate in being the present custodian of an antique orrery which possesses many fascinating features. The orrery is owned by Mrs. William Tidball, of Wallingford, Pa. Made in 1791 by W. & S. Jones, London, it is believed to have been the property of Horace Binney, a prominent figure in Philadelphia during the post-Revolutionary period.

This orrery has a finely engraved horizontal dial of German silver, nine inches in diameter, and it is supported by a graceful three-legged stand of brass, about 10 inches high. The dial is graduated at the outer edge for the 12 calendar months and their individual days, February having 28 days. Inside this is a graduation in zodiacal sections, of 30 degrees each. An elaborately engraved six-pointed star decorates the dial.

At the center of this main plate is a vertical spindle with a two-inch brass ball at the top to represent the sun. Three different mechanical arrangements are provided, the lunarium, the tellurion, and the planetarium; they cannot be assembled simultaneously.

The Lunarium has a flat, horizontal radial arm which is centered on the central pivot, and carries a pointer which travels over the day-to-dav graduations. The arm is actuated by a small brass crank with an ivory handle; the crank operates a set of gears concealed under the dial in a cylindrical chamber eight inches in diameter. The gears are connected with the central spindle, to which an adjustable nut clamps the radial arm, so the latter is made to revolve.

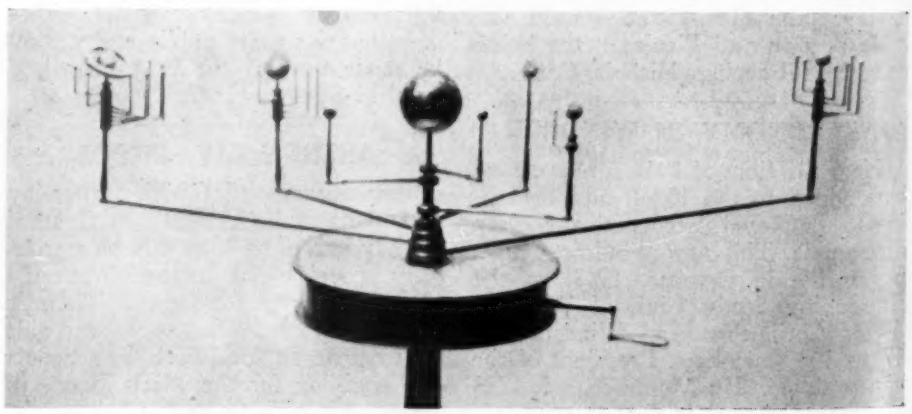
At the outer end of the radial arm of the lunarium is a vertical spindle which carries a short horizontal bar, eccentrically placed. At the short end of this bar is another vertical spindle bearing an ivory ball five eighths of an inch in diameter, representing the earth; at the long end another spindle carries an ivory moon one fourth of an inch in diameter. Motion is transmitted to these bodies by gears connected with a pinion attached to the radial arm and meshing with a circular rack extending entirely around the outer edge of the main dial. Thus, the earth and moon revolve with respect to each other while, at the same time, they move as a system around the sun, under the control of the circumferential rack.

By an ingenious device, the side of the moon away from the sun is covered at all times by a black cap, so that, as seen from the earth, the bright portion varies from crescent to full moon and back again to crescent, becoming invisible at new moon. The moon's phases are thus clearly demonstrated.

The relative movements of the earth and moon are controlled by three sets of gears operating, respectively: 1. the spindle carrying the earth and moon; 2. a circle which carries the line of nodes, or line of intersection of the moon's orbital plane and the ecliptic; 3. a circle which indicates the position of the moon's apogee and perigee. These three motions are independent of each other, each being accomplished in its proper relative period by a separate set of gears. One may interpret the moon's position and appearance and its place with reference to the nodes and line of apsides to find its position in the zodiac, its phase, the occurrence of eclipses, and whether central solar eclipses will be total or annular.

What is probably most important is that the independent motions can be adjusted so that the phases, the node positions, and the line of apsides all conform to these phenomena for any month as recorded in an almanac. Then, by turning the crank, lunar events can be ascertained for any year, past, present, or future.

The Tellurion has a radial arm similar to that on the lunarium, but carrying a three-inch earth globe. This globe rotates upon its axis and revolves around the sun when the operating crank is turned. The earth's axis maintains the correct inclination and direction in space and an accurate demonstration of the seasons is produced. By means of a pointer re-

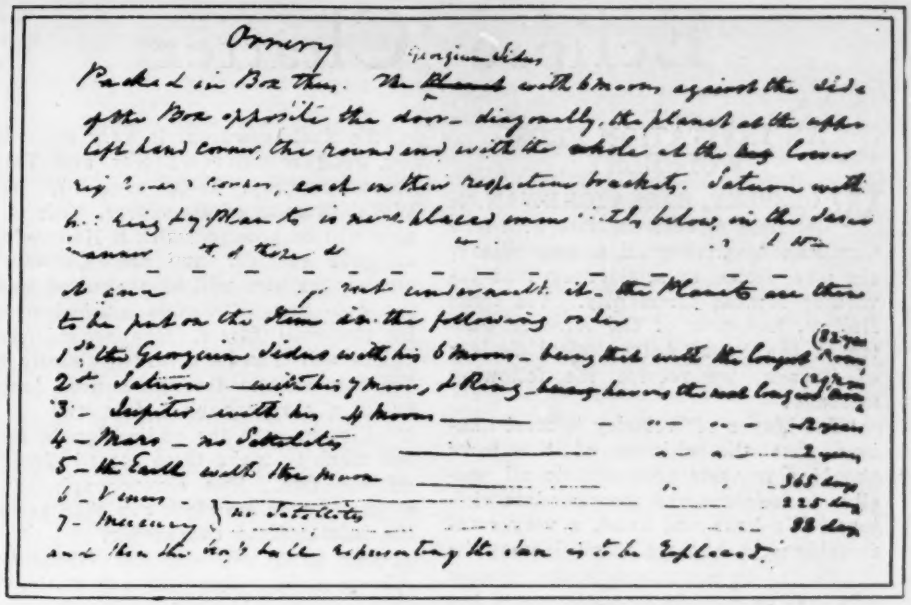


The normal arrangement of the planetarium, with the sun represented by the central brass ball.

volving about a small horizontal dial, graduated in the 24 hours of the day, the time of sunrise or sunset for any day in the year, at any point on the earth's surface, is indicated with considerable accuracy. This dial also gives the difference in time between the meridian passages of any two points.

The earth globe is, perhaps, the most fascinating part of the instrument. It is in excellent condition, and shows in great detail the various portions of the earth's surface as of the date of manufacture. This date is established by a small label printed upon the globe which reads: "Cory's Pocket Globe agreeable to the latest discoveries. London. Published by J. & W. Cory. Strand, Apr. 3, 1791."

The information as to points of geographical interest is surprisingly complete. Even little Pitcairn Island, of *Mutiny on the Bounty* fame, is in evidence. The United States, of course, is a very small area, with the balance of our present territory called "Louisiana," except the Pacific Coast, which is "New Albion." Australia is called "New Holland." Numerous voyages of discovery, with their routes, dates, and personnel, are shown. One of these indicates that Captains Cook and Clerke, in 1778, stopped at a point on what is now the coast of California. Another, touching the Sandwich Islands, records, "Owyhee where Cooke was killed, 1779."


Orrery
Georgium Sidus,
Packed in Box thus. The Planet with 6 Moons, against the side of the Box opposite the door - diagonally, the planet at the upper left hand corner, the round end with the whole of the long Lower leg 2 moons Saturn, each in their respective brackets. Saturn with 6 - his long leg Planets is next placed immediately below, in the same manner as the other
A gap for you to understand it - the Planets are then to be put on the stem in the following order
1st the Georgium Sidus with his 6 Moons - being the thickest with the longest (82 yrs) Rotation
2d Saturn with his 7 Moons, & Ring - being the next long leg and (29 yrs) Rotation
3 - Jupiter with his 4 Moons ——— 12 yrs
4 - Mars - no Satellites ——— 2 yrs
5 - the Earth with the Moon ——— 365 days
6 - Venus - no Satellites ——— 225 days
7 - Mercury ——— 88 days
and then the long ball representing the Sun is to be replaced.

The top and bottom portions of the page of instructions and data on the solar system.

THE PLANETARIUM presents each planet up to and including Uranus, then called Georgium Sidus. Each planet is an ivory ball at the end of a brass arm of length corresponding to its distance from the sun, but, of course, not made to true scale. Each arm is placed upon a separate bearing at the central pivot, with a most perfect frictional mechanical fit, and by turning the crank all the planets revolve around the sun in their proper relative periods, except Uranus, which is stationary. Its period is so long that it was evidently considered impractical to provide the mechanism to make it revolve.

All planets are colored black on the side away from the sun—a pleasing bit of realism. Jupiter has four moons, the number known at that time; Mars has none; Saturn has seven besides rings of ivory; Uranus is shown with six satellites. This last is an interesting piece of erroneous conception. Sir William Herschel discovered Uranus in 1781, and subsequently thought he had observed six satellites, and he even computed their distances and periods. This information is contained in Ferguson's *Astronomy*, London edition of 1809, and also in Burritt's *Atlas*, published in 1835. It is now known that Uranus has only four satellites, and with his equipment Herschel could not have seen more than two of these. But Messrs. W. & S. Jones have perpetuated the error of the discoverer by giving the planet Georgium Sidus six moons in their orrery. None of the satellites in this instrument has any mechanical motion, but each may be moved to any desired position.

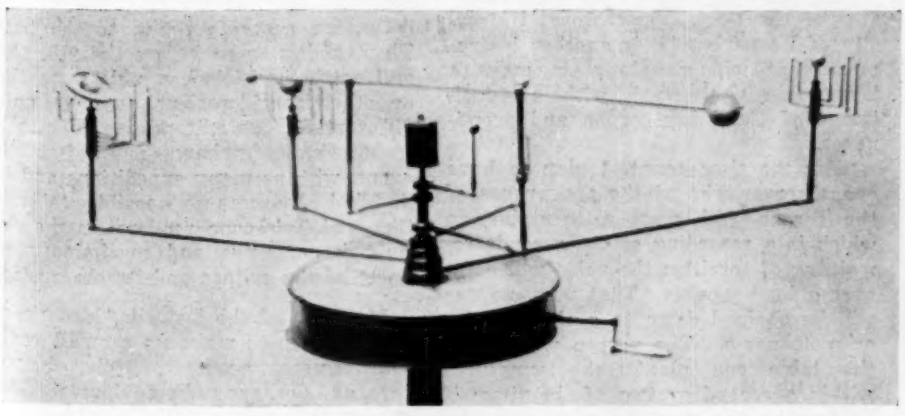
Another fascinating bit of realism is a brass lamp which can be substituted for the sun in the planetarium setup. Its flame is in the plane of the planets, so it will illuminate them in a darkened room. A residue of grease or oil shows the lamp to have been employed in this manner.

An ingenious feature of the orrery is an arm which, in the planetarium arrangement, may be connected simultaneously at the spindle carrying the earth and at that of another planet. The motion of this arm while the system is in operation portrays the apparent motion of the planet as seen from the earth, including the retrograde motion of a superior planet. This device is made for use only with Mercury, Venus, and Mars.

Still another provision is a connection of this arm simultaneously at the central spindle of the system and at the spindle carrying the earth. The operation will then give an illustration of the phenomena of the ancient Ptolemaic system, in which each planet was thought to revolve in an epicycle around a point which was assumed to revolve about the earth as a center.

The entire mechanism of the orrery is made to fit compactly and securely in a mahogany cabinet about two feet high, with handles for transporting it. A page written by hand upon paper bearing a watermark of the year 1819 accompanies the orrery, giving the average distances from the sun and

(Continued on page 11)



The brass lamp here represents the sun, and the rod to illustrate the apparent motion of Venus is in place.

Eclipse Chatter

AN INVITATION FROM WOLSELEY

WOLSELEY, SASKATCHEWAN, is anxious to accommodate with true Canadian hospitality all eclipse observers who decide to settle near that favorably located community. Via Cyril Hallam, treasurer of the Windsor Centre of the Royal Astronomical Society of Canada, we receive the following message:

"The Mayor of Wolseley is most anxious that the citizens of the town should play their part and do all possible to welcome and accommodate visitors. We have one hotel, a very comfortable one, but we think it may be insufficient to accommodate the number who may be in town as observers of the eclipse on the weekend of July 9th. We are anxious that Wolseley should make its contribution to this special event. Private homes can certainly be made available. I should suggest that persons intending to come to Wolseley on the weekend of the eclipse send their requests for accommodation to the Mayor of Wolseley, Sask."

MILWAUKEE EXPEDITION

E. A. Halbach, of the Milwaukee Astronomical Society, reported on March 30th:

"Mr. Herbert Cornell, M.A.S. secretary, has arranged for a party of about 10 to observe the eclipse from Sandy Island in the middle of Lake Winnipeg, traveling by steamer from Winnipeg. They have been invited to be guests of the commercial fishermen who use the tiny island each summer. Accommodations are very limited, we understand. No special observing program has yet been planned by this party.

"I am arranging a party of eight or 10 to make some extensive observations from a location southwest of the town of Pine River. The exact location may be changed later for topographical reasons, but it seems likely that it will be in Duck Mountain Forest Preserve. At least two autos will be used, and possibly one trailer, to transport the scientific equipment and the camping facilities. The party will include John Willis, formerly of the Naval Observatory and now in Milwaukee; Arpad Elo, director of research with the Perfex Corp.; Alfred Memmel, machinist by trade; C. M. Prinslow, electrical engineer in charge of the Port Washington power plant; the writer, professor of electrical engineering at Marquette University; Mrs. Prinslow, Mrs. Halbach, and possibly others.

"The main piece of equipment will be an f/6, 24-inch focal length objective-prism camera to photograph the flash spectrum at second and third contacts. According to the program proposed by Professor Lindblad, of Sweden, timing of the flash spectrum is very essential for good results (see **Sky and Telescope**, January, 1945, page 8). The WWV, Bureau of Standards, time signals will be received with a Halicrafter all-wave receiver and the 1,000-cycle seconds impulse will be separated from the 440- and 4,000-cycle musical notes by electrical filters. The seconds impulses will then be recorded directly on the moving film through a neon lamp, or on a chronograph before and after totality, in case the radio signals fade too much to make them record directly on the film. The chronograph or a seconds-pendulum clock can then act as the intermediate timekeeper.

"Our party will also have about five other cameras, both still and motion in both color and black and white."

PHILADELPHIA EXPEDITION

Dr. Roy K. Marshall, director of Fels Planetarium, plans to go into Saskatchewan, to either Montmartre or Wolseley. He writes: "One of my requirements is a source of 110-volt, 60-cycle current, for at least one of the instruments I shall take is equipped with an electrical driving clock. It is a 4-inch f/7 Ross-Fecker camera belonging to the Flower Observatory, University of Pennsylvania. With this instrument, and a 5-inch f/2.5 Ektar with coated surfaces, long exposures to show the greatest coronal extension will be made.

"Because of the short duration of totality, each instrument will take only one picture, either long or short exposure, thus avoiding confusion and the waste of precious seconds in pulling and replacing slides and changing plateholders. Two 4-inch f/15 lenses, with Polaroid screens at 90 degrees, for isolation of polarization effects of the outer corona, may be attached to the 4-inch camera, if the mounting will stand it. These two, and the 4-inch Ross-Fecker and the 5-inch Ektar, would be mounted on one axis, electrically driven.

"The 40-foot focus f/80 photoheliostat of the Cook Observatory, University of Pennsylvania, is another instrument that will go along, to make a large-scale photograph with a 4-inch image of the inner corona and prominences.

"For the time count, I plan to have one observer who at the appearance of the corona will start a turntable on which is a recording of the seconds remaining of totality; the voice will come over a loud-speaker. That way, no one will be chained down to a chronometer or metronome. The person who starts the table can also make exposures within a second or two of the time; if he fumbles the start, he must stand by to count in person, and an alternate will make the exposures."

SOME PERSONAL NOTES

H. S. McClung, of Regina, Sask., on April 11th wrote that "from the Canadian-U. S. border up to about Kendal and Montmartre there is very little bush, mostly open, flat prairie. I am informed that about midway between these two towns, on Highway 16, there is a high spot overlooking all the surrounding country.

"Personally, I expect to go down near Wolseley someplace, the exact spot to be selected later."

F. W. C. Jones, of Trenton, Mich., wrote on April 11th, "My original plans were to go to the shore of Hudson Bay. However, since I have been informed that it is not an easy job to get in there that early in the year, on account of ice, I have shifted my attention to a position farther west. Also, considering available weather information, it seems the farther you are from the lake region, the better the chances of clear skies at sunrise. With all of this in mind, I don't mind the fact of not being at Hudson Bay. However, I am not quite set whether it will be Pine River, Man., in the lake region, or Wolseley, Sask., out on the prairie. Pine River will give 36 seconds while Wolseley will give 34 seconds totality, figured on central line data. I am rather leaning toward Wolseley.

"My wife and I plan to make a motion picture record of the eclipse from start to finish. For this purpose we are using a coelostat and 16 mm. motion picture camera with black and white film. With the use of a Graflex, we would like to make an exposure, on the same film, about every 15 minutes. Along with this, we can use a 16 mm. motion picture camera with Kodachrome and expose a short sequence every 15 minutes. This should show nicely the changing colors of the landscape, and may be very interesting, especially if we include a short sequence just as totality starts and one just as it ends."

The editors, with a 6½-year-old assistant, and Beaumont J. Morehouse, of Ridgefield, Conn., plan to arrive in Regina on July 2nd, and spend that week organizing farmers and townsfolk along the edges of totality to find whether or not they see the corona, thus helping determine accurate limits to the path. Then, a day or so before the 9th, they will settle in Wolseley, unless weather or other considerations seem to point differently. The editors also hope to be in touch, beforehand and after the event, with as many expeditions and individual observers as possible, to bring **Sky and Telescope** readers, in the August issue, news and preliminary reports of the eclipse and its observation.

Members of the Detroit Astronomical Society plan to make up a small party, with cameras, accurate watches, binoculars, and perhaps radio equipment. They expect to locate at Wolseley, although detailed plans of their observing program have not yet been received.

NEWS NOTES

By Dorrit Hoffleit

COSMIC RAYS AND THE RED SHIFT

Two recent contributions by investigators of the phenomena of cosmic rays are of considerable astronomical interest. A. J. Shneiderov, of George Washington University, argues that the red shift observed in the spectra of exterior galaxies, which furnishes the observational basis for the expanding universe theory, is caused by an increase of the wave lengths of photons emitted by the galaxies, the increase taking place as these photons journey toward the Milky Way.

Meanwhile, Professor E. A. Milne, of Oxford, England, links cosmic rays with red-shift phenomena, the cosmic rays being merely what is left of high-frequency radiation that started on its way when the universe first came into being. Science Service further quotes Professor Milne:

"The wave length of a photon is proportional to the epoch at which it is observed, independent of the value of its mean free path. . . . The red shifts in the spectra of galaxies, usually interpreted as showing that a galaxy is moving away from us, and the 'aging' of light with the passing of eons by which the wave length of a photon steadily increases, are substantially the same."

MEDAL TO SOLVER OF A MYSTERY OF THE CORONA

According to the British journal, *Nature*, Professor Bengt Edlén, of Lund Observatory, Sweden, has been awarded the Gold Medal of the Royal Astronomical Society for 1945, for his identification of the origin of the principal lines in the coronal spectrum. In the sun's corona, comparatively familiar atoms, such as nitrogen, behave so much differently from their well-known laboratory habits that the atoms in the corona were known only by their alias, "coronium," until detective Edlén a few years ago unearthed their identity.

SUPERNOVA IN CANES

On April 6th and 7th, working with the 100-inch telescope at Mount Wilson, M. L. Humason discovered a supernova in the system which is a satellite of M51, the famous Whirlpool galaxy. The satellite, known as NGC 5195, was being observed by Humason for the first time in three years, and on April 6th he noticed the presence of a faint star with which he was not previously familiar. He confirmed his suspicion that it was a supernova in that distant galaxy by obtaining its spectrum the following evening—it was that of a supernova about 65 days past maximum.

On April 12th, the star was at magnitude 16.0 photographic and 14.0 photovisual. Its estimated maximum brightness was 11.0 photographic. "It was certainly fortunate that I had Messier 51 down on my observing program for the night of April 6th," Mr. Humason said, "for the star was fading so rapidly that I would probably have overlooked it a few weeks later. The fact that a supernova appears in a spiral nebula only once in about every 400 years makes the coincidence seem all the more remarkable. Also, if the star had not been so close to the central nucleus I feel sure I would never have noticed it."

OPTIMISTIC OUTLOOK

A United Press clipping from California tells us that work at Palomar, where the 200-inch telescope is still unfinished, is being resumed. Dr. Fritz Zwicky is the first war-working scientist to return to the observatory.

VELOCITY OF LIGHT STILL CONSTANT

"Among the distinguished observers who have measured the velocity of light, an implicit faith in its constancy seems to have prevailed. But other writers, comparing the published observations, have interpreted the apparent differences as secular and periodic variations."

So comments Harold D. Babcock in a recent issue of the *Astrophysical Journal*, where he reviews a paper* on the velocity of light by N. E. Dorsey, formerly of the U. S. Bureau of Standards. Dr. Dorsey has made an extensive reanalysis of much of the published data. He finds that there is no indication of any progressive change in the velocity, the best value for which he determines as 299,773 kilometers per second (in a vacuum) plus or minus 10 kilometers a second.

Dr. Babcock compares Dr. Dorsey's investigation with another analysis of the same material by Birge in 1941. The two methods of study are quite different but the conclusions are consistent. Birge found the velocity as 299,776 with an uncertainty of four kilometers per second; concluded that there is no secular variation and, moreover, disproved an earlier theory of periodic variation.

*Transactions, American Philosophical Society, Philadelphia, 34, Part 1, 1944, 110 pages. $2.25.

ORIGIN AND EVOLUTION

Evolution is far from being a topic which is solved. Within the past few months several contributions have appeared on the subjects of the origin of the solar system, and stellar and planetary evolution.

In the *Monthly Notices* of the Royal Astronomical Society, H. Bondi and F. Hoyle discuss the mechanism of accretion by the stars. They show that the gravitational interaction between the interstellar material and the stars leads not only to an increase in the masses of the stars but also to a decrease in their peculiar velocities. Yet "the evolution of a star is dominated by a struggle between opposing forces."

On the one hand, the resistance of the interstellar material constantly tends to reduce the velocity of the star, while, on the other hand, the perturbing force due to the changing gravitational field of the galaxy as a whole tends to increase the velocity. Should the changing gravitational field predominate, large velocities will ensue and the stellar mass cease to increase; but if the interstellar drag is the more important factor, the star's mass and luminosity will increase. The authors comment, "Indeed it would appear that the question of whether the rate of accretion of hydrogen by a star is sufficient to balance the hydrogen destroyed by the energy generation in its interior is determined by the battle between the opposing forces mentioned."

Observatory, another British publication, quotes from the Moscow *News* on a "New Theory of the Origin of the Planets," on which O. J. Schmidt, a Soviet mathematician and geophysicist of Arctic exploration fame, is said to have worked for nearly 20 years, and which "created quite a stir." According to his theory, a star (for example, the sun), passing through one of the meteorite clouds in the Milky Way, captures some of the meteorites. The capture leads to the formation of planets revolving around the star. It is quoted that whereas previous theories on the origin of the solar system have been purely descriptive, Schmidt's theory leads to mathematical formulae that agree with astronomical observations. *Observatory* only quotes and does not comment on the theory.

Several *Astronomical Circulars* (July-September, 1944) have been received from the Academy of Sciences of the U.S.S.R., and in these N. N. Parijsky summarizes his discussions on the origin of the solar system. Russell's objections (in 1935) to the Jeans and Jeffreys theory are borne

out mathematically. Material ejected from the sun by the tidal action of a passing star would drop back on the sun or else onto the passing star, except in cases of critical velocities of ejection which would yield planets with nearly circular orbits in the vicinity of Roche's limit. The tides on the sun have been suggested as a mechanism for increasing the size of a planet's orbit from the original small value at Roche's limit. Parijsky finds, however, that this mechanism cannot be very effective: for the earth's orbit to have attained its present size from a semi-axis of a few solar radii would have taken much longer than 10^{15} (a quadrillion) years.

"The Evolution of the Giant Planets," by David W. Dewhirst, in the *Journal* of the British Astronomical Association, deals with the physical chemistry of the major planets. He assumes that they were originally composed of the same array and proportion of atoms as stellar material. The proportions are important since the evolution of a planet depends heavily on them. As cooling of the primordial mass progressed, molecules and solid matter were formed. It can be predicted what the remaining gases should be in the present atmosphere; and the theory appears adequate to account for the observations. The explanations of the formation of dark belts, coloring, and Jupiter's red spot, are still subject to speculation. The solution depends very much on careful study of such planetary features, a problem in which accurate drawings by amateur observers are useful.

Finally, we have another paper by F. Hoyle, published in the *Proceedings* of the Cambridge Philosophical Society, also concerning the origin of the solar system . He remarks on the divergence of views on this subject, adding, "This widespread disagreement amongst astronomers seems very remarkable for it appears possible to show not only that all theories at present available, except one, are untenable for fairly obvious dynamical or physical reasons, but that the remaining possibility fits the requirements of the problem so well that its applicability can hardly be denied."

This favored theory assumes that the sun at one time had a companion star which became a nova. At the time of its outburst, the nova divided into two main segments separating from each other at a relative velocity of the order of 2,000 kilometers per second—greater than the velocity of escape from the sun. The center of gravity of the nova after outburst would, however, still retain its initial orbital velocity around the sun, and a portion of the filament of material between the two main segments of the original companion would have been captured by the sun (from the region of the center of gravity of the erupted companion), thus forming planets.

Hoyle shows that the material available for planets under these conditions would be about 1/10 the solar mass. He concludes: "Since an appreciable fraction of stars of mass comparable or greater than the solar mass are known to be members of binary systems the number of planetary systems must be at least of the same order as the number of novae that have occurred in this class of star."

The Mysterious Blast of May Fourth

RADIO news-broadcasts heard over New England stations the morning of May 4th included reports that inhabitants of the Middle Atlantic states had been badly startled early that morning by a mysterious explosion and flash of light. Some thought munitions plants in Wilmington and vicinity had blown up; residents in the Delaware city, however, thought a Philadelphia plant had exploded. At this distance, we surmised it was a bolide, an exploding meteor, and later in the day news reports included the suggestion to this effect made by Dr. Roy K. Marshall, director of the Fels Planetarium in Philadelphia.

Hundreds of persons subsequently telephoned the Fels Planetarium to report their experiences; more than 50 letters were received and these have been turned over to Dr. Charles P. Olivier, president of the American Meteor Society. Meanwhile, at the request of Dr. Olivier, newspapers served by Science Service published requests for observations, and over 100 additional letters have been received. These early "returns" are sure to be augmented as a result of further questionnaires circulated by Dr. Olivier and by the Fels Planetarium. Anyone who actually saw the burst or explosion (not just the light from it) or who saw a meteor at about 3:35 a.m., May 4th, should communicate immediately with Dr. Olivier at the Flower Observatory, Upper Darby, Pa.

Dr. Olivier wrote on May 7th: "No doubt it was a bolide, occurring at 3:38 a.m. within a minute. It lit up the whole sky; the explosion was accompanied by seven seconds of lesser reverberations. Windows in many houses shook. I have no data on path, but so far accounts would put the explosion south to southwest of Flower Observatory and from 20 to 25 miles away. Cloudy skies prevented good azimuths and the above position is very preliminary."

On May 9th, Dr. Marshall wrote, in part: "Many thousands of people of Philadelphia and vicinity were awakened by a terrific blast, preceded by a brilliant flash of light, at about 3:35 a.m., Friday, May 4th. Estimates of the time range from 3:35 to 3:40; estimates of the interval between the flash and the explosion range from two seconds to five minutes, and not at all in agreement with the positions of the observers. Unfortunately, it was overcast throughout most of the Philadelphia area, so good observations are not numerous. Knowledge of the meteor's path may not be obtained, but we may determine its height and earth-point. The possible area for meteorites dropped by the bolide is that part of New Jersey including Salem, Gloucester, Camden, Cumberland, and Atlantic counties. The explosion probably occurred between Wilmington and Philadelphia, at a height of the order of five miles.

"Reports of the fireball have come from as far away as Martinsville, Va., 325 miles southwest, and Naples, N. Y., 200 miles northwest, of this city. Each reported the 'brilliant lighting of the room.' From Gerrardstown, W. Va., a correspondent states, 'I am 69 years old and that was the greatest flash of light I have ever seen.' From Long Branch, N. J., 'It made the night as bright as day, passing to south of me from west to east.' A clock in West Chester, 25 miles west of Philadelphia, a tall, pendulum clock, stopped at 3:38. From Philadelphia, there is one report of light 'coming from the west, no higher than the bedroom windows. . . . In one or two minutes came the terrible crack and the whole house shook, and it seemed to me like an odor of sulphur or powder, for about five minutes.'"

It is suggested that from Harrisburg or westward this meteor may have been seen, as the sky was probably clearer there. A few reports from persons who actually saw the meteor, even though it was low on their horizon, and who can give the altitudes and azimuths of its beginning and ending points, would be of tremendous value in tracing the flight of this dynamic intruder.

THE SUN AND ECLIPSES

(Continued from page 4)

asteroids, and all. At the moment, the sun is passing through an open cluster composed partially of five of the stars in the Big Dipper, and Sirius, Beta Aurigae, and Alphecca.

The sun rotates on its axis; it travels through space among the billions of stars of the Milky Way galaxy; it participates in the immense rotational movement of the galaxy; and, whatever the goal of the galaxy, toward whatever remote point of the universe it is speeding, there too do you and I make our rapid way—children of the sun.

ASTRONOMICAL ANECDOTES

GALAXIES, HERSCHEL, AND THE STRUCTURE OF THE UNIVERSE

A FEW years ago, there was issued from the Lick Observatory a folio of magnificent photographic prints from negatives made with the 36-inch refractor, and with the Crossley reflector, one of the finest telescopes in the world. Several of these pictures have appeared on the back covers of *Sky and Telescope*.

One of them, February, 1943, includes the system of three galaxies in Andromeda — the great spiral M31 and its two companions—and, even in the reproduction, one can trace what is quite conspicuous in the original print. The elliptical galaxy NGC 205, long noted as "peculiar," certainly appears to me to be a spiral. If other photographs should show this, we are faced with a new midget class of spiral and, perhaps, with the notion that all elliptical galaxies are really spirals.

It is this same elliptical galaxy which, with M32 and the nucleus of M31, has been resolved into stars by Dr. Walter Baade, using the 100-inch telescope with red filters and fast red-sensitive emulsions, as reported in News Notes in this magazine last December. His discovery came as anything but a surprise to me—I would have been very surprised if these objects could not be resolved into stars. Several theorists tried to prove that the so-called elliptical galaxies might be composed of dust, illuminated by light diffused from a single central star. It's a good thing they didn't succeed in convincing anyone but themselves!

To go far back in the history of this same subject, William Herschel was among the pioneers who rightly foresaw the distribution of the matter in the universe in terms of galaxies, or aggregations of stars. In 1783, he started his program of "sweeps" with large reflectors; three years later he published a catalogue of a thousand newly discovered nebulae and star clusters. A list of another thousand followed soon, and in 1802 a list of 500, bringing the total to 2,500 nebulae and clusters in 20 years.

In 1785, Herschel expressed his belief that many of the nebulous objects he could not resolve into stars must nevertheless consist of stars and, in a sense, might be considered aggregations like the one in which we live; in 1786 he remarked that he had discovered 1,500 universes. But he was convinced, too, that the obvious star clusters were subordinate groups in the Milky Way system, and that they had drawn in the stars in their neighborhoods.

He became interested in his classification of the nebulae, ranging from slightly nebulous stars to the large, chaotic forms like the fine object in Orion. He believed the stars to be condensed from the nebulae, thus anticipating by some years the speculations of Laplace, although his publication of the idea did not occur until 1811, after Laplace had propounded his nebular theory. Herschel felt convinced that there were some real nebulae, in addition to the unresolved stellar groups that resembled nebulae. His conviction about the existence of other galaxies was growing weaker, however.

His surveys of the stars were discussed at first on the assumption of equal average luminosities, with distances varying the apparent brightnesses. His "cloven-disk" theory of the structure of the Milky Way came into being and, strangely, was the only part of his work in this matter that other astronomers remembered. Between 1785, when he announced it, and 1802, Sir William gradually let the observational evidence convince him that there were many obvious clusterings. In 1802 he wrote, "I am now convinced that the Milky Way itself consists of stars very differently scattered from those which are immediately about us. This immense starry aggregation is by no means uniform. The stars of which it is composed are very unequally scattered." Still later, in 1811, he wrote, "An equal scattering of the stars may be admitted in certain calculations; but when we examine the Milky Way, or the closely compressed clusters of stars, of which my catalogues have recorded so many instances, this supposed equality of scattering must be given up."

Thus the nice cloven disk that he had first derived was abandoned, except in very general principle, in his later speculations. Not many astronomical writers make this clear. It is still good, in principle, but Herschel's growing caution with increasing years led him to distrust of it instead of further improvement.

It is always interesting to try to trace to its origins the choice of a particular profession. It would be very exciting to be able to say that because of a certain incident which occurred on a certain day, William Herschel became the first modern sidereal astronomer, interested in the stars for their own sakes and not as fixation points for the solution of problems in spherical trigonometry.

We know that Isaac Herschel, father of William (born Friedrich Wilhelm), Caroline, and eight others, was a good musician; additionally, he had at least a mild interest in astronomy and taught his children the constellations, while Frau Herschel did everything she could to prevent the children from having any love for learning. Certainly, between 1755 when, as an oboeist in the band of the Hanoverian Guard, William first visited England, and 1767 when, at the age of 29, he became organist in the Octagon Chapel at Bath, he did little thinking about astronomy.

With a steady income assured, he began to think about leisure pursuits; he commenced to study languages and to read mathematics. One of the books in the latter subject that was recommended for mathematical philosophy was Ferguson's *Astronomy*, and in reading it the organist of Bath sealed his destiny. If there is one incident in the life of Herschel that we can hold responsible for his turning to astronomy, it is the accident of his reading this little book by James Ferguson. Of another book by the same accomplished author, I shall have something to say next month.

R.K.M.

ANTIQUE ORRERY

(Continued from page 7)

the periods of revolution in years for the planets. Its main purpose, however, appears to have been a very meticulous direction to guide the packing of the various parts properly in their box.

At the New York Public Library may be found a price list of W. & S. Jones, dated 1812, and listing, among others of their products, an orrery which is described as follows:

"A very complete Planetarium, Tellurion and Lunarium in three parts, all in brass, shewing by this means the various phenomena in a perfect and perspicuous manner, contrived by the late Mr. B. Martin, packed in a portable mahogany case—37-16-0."

Messrs. W. & S. Jones were in business at 30 Holborn, London, from 1790 to 1815, according to a most interesting paper by Harrold E. Gillingham, entitled "The First Orreries in America," published in the *Journal* of The Franklin Institute in January, 1940.

The instrument for sale seems to correspond quite closely with the orrery described in the present article.

ELEMENTARY SCH

By JOHN STERNIG, Director of Science

THERE are still too many people who feel that astronomy is an advanced subject, beyond the interest and comprehension of young children; this, in spite of the fact that studies of children's interests place curiosity about the heavens up near the very top. In an effort to encourage other teachers and amateur astronomers, the author wishes to share some of his experiences in helping young people learn about astronomical matters. Teacher readers may see possibilities in this article for their own work with children, and other astronomy enthusiasts may be encouraged to share their knowledge, interest, and equipment with the schools of their communities. Modern education welcomes the use of such fine community resources.

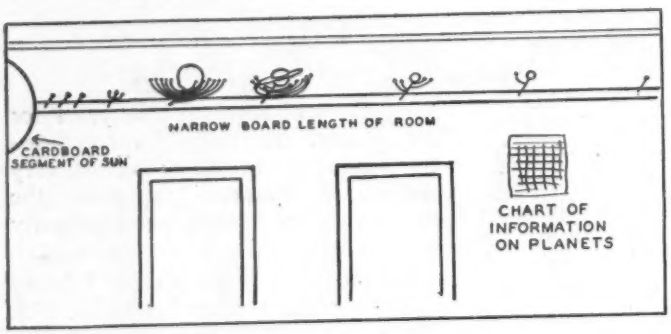
The author has been a classroom teacher and as such has taught children from first grade through eighth. So the material which follows is not theory, but has been tested by actual work with children of all ages.

Children are ready for simple astronomy from the time they are old enough to become aware of the sun, moon, and stars. Parents should guide their interest and observation in such matters as the directions of sunrise and sunset, the moon and its phases, the stars and planets, cause of day and night, observations of seasonal changes, and other similar astronomical events. This can all be made simple enough for even a preschool child; yet who can deny that the average adult himself pays little if any attention to these things? They are just taken for granted, and children pick up the same unseeing way of living. Parents can do much to awaken children's interest in all manner of things. Quite aside from the science involved, this makes for a more natural family relationship in an age when children are left too much on their own, or in the care of other people.

Once a child reaches school, the teachers work to develop interest and ability in many subjects, but often their own lack of information about astronomy leads to neglect of this area. However, up-to-date astronomy books are plentiful and all that is required is enough interest to find and read them.

Astronomy work may begin in any grade. Children come to school bubbling with questions and observations about things they see, hear, or read: meteors, auroral displays, rings around the moon, a brilliant star in the sky, or a news account of a coming eclipse. These lead to group discussions if the teacher provides the opportunity. From there, teachers can sense children's needs and can act to satisfy them in astronomy as they do in other subjects. In the lower grades, children are generally content with simple lessons which answer some special question, although the author has had a third grade which became so intrigued that several months were spent in a very complete study.

A group which shows a desire for such a study needs to plan carefully with the teacher about all the things they wish to know, listing their questions and then organizing for content. Teacher-pupil planning of this sort is the surest way to keep interest high, since it makes the subject the children's own and not just something else the teacher says must be done.



A larger model of the solar system stretches from one end of the room to the other.

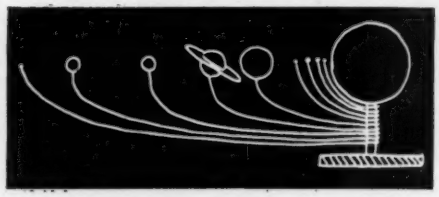
The organization eventually might result in an outline somewhat like the following:

1. SOLAR SYSTEM. The sun (our star); planets and asteroids; the earth (our home); moons; comets; meteors; aurorae; where all this came from.

2. STELLAR SYSTEM. Space; stars; nebulae; our galactic system; other galaxies; constellations and their stories (facts and fiction).

3. ASTRONOMERS' TOOLS. Observatories; telescopes; other things astronomers use.

4. WHAT USE IS ASTRONOMY? Navigation; time; latitude and longitude; adding to man's knowledge.



In this simple model of the solar system the size scale is roughly correct; distances are only proportional.

Such an outline can always be checked against astronomy books to insure completeness.

Once these preliminaries are out of the way the fun can begin. Group discussions rather than reading alone should be the main technique and, above all, activities in which children can engage are a must. It is these which keep interest and make astronomy more than just another thing to learn about. The following list of tested activities may serve as suggestions for things to do.

Models of the solar system
Written reference projects of the children's own choosing
Charts of the solar system, drawn or cut out of colored paper
Charts of the moon's phases
Scrapbooks of astronomy pictures and articles (*Splendors of the Sky*, Sky Publishing Corporation, especially valuable)
Phases of Mercury and Venus
Charts and models of eclipses
Earth-moon models
Maps of the moon
Models of the moon's surface done in plasticine
Drawings and models of planets
Drawings of imaginary trips through space or to planets
Model rocket ships
Drawings and models of types of telescopes
Making experimental telescopes
Charts to show distances and time required to reach planets
Handmade slides on ground glass for assembly programs
Star maps and model planetariums
Drawings of observatories

Space will not allow detailed descriptions of all of these. Their natures are indicated by their titles. Information in astronomy books, plus a little imagination, will supply the details for most of them.

One especially popular project is the solar system model. It is made of wood for the base, and wire to hold the planets, which are of a mixture of asbestos powder and paperhanger's glue or plain flour mixed to make a

HOOL ASTRONOMY

of Science, *Public Schools, Glencoe, Ill.*

claylike substance. The scale here given is a workable one, reasonably accurate though not critically so.

Name	*Diameter in inches*	*Distance from sun in inches*
Sun	3*	—
Mercury	1/16	3/16
Venus	⅛	5/16
Earth	⅛	⅞
Mars	3/32	1¼
Jupiter	1 5/16	2¾
Saturn	1 1/16	4½
Uranus	½	7
Neptune	½	10
Pluto	3/32	12

*This ought to be 10 inches, but it would then be too large for the stand.

The sun and planets are made of the asbestos mixture and mounted on wires of the right length. These wires are curved around a dowel rod grooved to hold them and mounted on a wooden base. The wires should be free to revolve around the sun, which is set at the top of the rod. Water color or oil is applied to make the sun yellow, Mercury orange, Venus white, earth blue, Mars red, Jupiter pale orange striped with cloud bands, Saturn striped yellow, Uranus and Neptune blue-green, and Pluto yellow. Saturn is also fitted with a cardboard ring about 2½ inches in diameter with an opening which allows it to fit snugly over the planet.

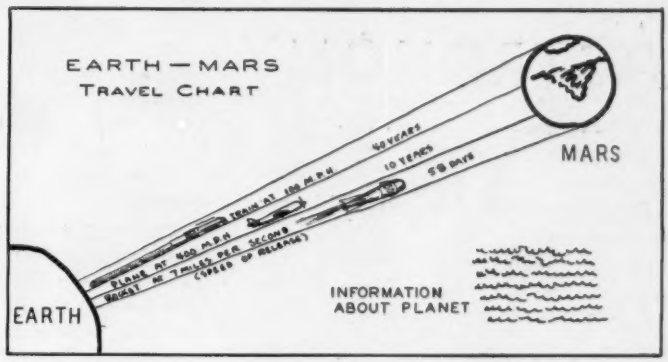
With so small a model the satellites cannot be included, but on a larger scale they can be added by fastening smaller wires to the larger ones holding the planets. The longest wall of the classroom can be measured and a distance scale planned to put the solar system along a narrow board cut to fit that wall.

In nearly all models of this sort, even in large orreries, it is important to realize that the distance and size scales are not alike. If the distance to Pluto were only 12 inches, on the same scale the planets would be too small to be seen; in a room 45 feet long the planets would be smaller than the period at the end of this sentence. This and similar inconsistencies must be made clear as the children work with the models.

A chart which shows the planet distances and the time required to reach them at various speeds is interesting, and is a good arithmetic project, too. Here it should be emphasized that a speed of over seven miles a second is necessary for a projectile or rocket actually to leave the earth.

An earth-moon model may make use of a small commercial terrestrial globe; care should be taken to incline the moon's orbit, or an eclipse occurs at each revolution. An eclipse model can be made of tissue paper over a three-inch circular opening in cardboard with a 3⅛-inch disk of cardboard on a stick for the moon. Holding the "sun" against the light while the "moon" moves slowly across the tissue opening gives the illusion of an eclipse.

Making slides is another fine activity, especially in preparing an assembly program in which the children can share their study with other groups. Frosted glass slides of standard size are used; the Keystone Company has regular kits with special crayons and inks for this purpose, useful in all manner of school work. Each child may make a slide and prepare a talk to give as it is shown. Outdoor dramatizations of the solar system are fun for smaller children. The school grounds are measured and a distance scale for each planet is established. One child is the sun and stands in the middle. Others are planets, accompanied by moon children as they revolve around the sun at relative speeds. Teachers can work out many variations on this theme.



This shows a typical wall chart of the times required to reach a planet. Considerable variation is possible in planning such charts.

Children should have the experience of seeing the things they study about. This is where the community astronomers can help by bringing their telescopes and conducting night observations with groups of children or daytime search for sunspots. Small groups are easier to handle and extra binoculars and opera glasses are useful to keep interest as the youngsters wait their turns at the large telescope. The author frequently shows sunspots, by the projection method (as shown in the front-cover picture), but as few teachers own telescopes, most schools have to depend on the amateur astronomers of the community.

In some regions, it is possible to have classes visit nearby observatories or perhaps a planetarium. Such visits are high spots of school experience and are never forgotten. They help to establish a feeling for astronomy which lasts long after facts are forgotten.

Astronomy belongs in the elementary school. It gives children an awareness of the heavens, of the vastness which is greater than that of their earth. It gives them a perspective in understanding space relationships; a realization of organization and order in the universe; a feeling toward the Creator in a way that no other science can give. And finally, it opens a lifetime of interest in a hobby that is without peer—amateur astronomy.

Star-Gaze

Head down I hang into the dark
While earth careens in space,
Drawn down to distant suns and moons,
Yet holding fast my place.

If I could loose both feet at once—
And like a shooting star
Streak down through sweeping arcs of night
To where the planets are,

The universe would crash to bits
And, systems gone askew,
Astronomers and physicists
Would have no more to do.

If I could fall into the night
It would seem more than strange
A single will as small as mine
Could start so vast a change.

Instead I seem to stand erect
And see the heavens roll,
Marking the constellations while
They march around the Pole;

Unmoving as the planet spins
Through each celestial phase,
I find it stranger, harder still
Simply to stand and gaze.

ISABEL TAYLOR

★ ★ ★ ★ ★ ★ ★ ★

For
Fall Classes

★

ELEMENTS
OF
ASTRONOMY

New Fourth Edition

By EDWARD ARTHUR FATH

Professor of Astronomy
in Carleton College

382 pages, 6 x 9,
253 illustrations. $3.00

McGraw-Hill Astronomical Series

This successful standard text has been revised to include new material accumulated since the publication of the third edition. Many sections have been rewritten on the basis of further classroom experience; diameters and distances have been corrected for new values of the solar parallax; in the chapter on practical astronomy the principles of navigation have been rewritten and amplified; the chapter on Other Galaxies has been entirely rewritten; and a new chapter on the structure of the galactic system has been added.

Send for a copy on approval

McGRAW-HILL
BOOK COMPANY, Inc.

330 West 42nd Street, New York 18, N. Y.

★ ★ ★ ★ ★ ★ ★ ★

BOOKS AND THE SKY

THE BOOK OF THE STARS

Louis Sutherland. Bernard Ackerman, Inc., New York, 1944. 230 pages and maps. $3.00.

ACCORDING to its publishers, this book covers everything general adult readers are likely to want to know about the stars, and also provides a complete astronomy for junior high and high school students. It might well serve as an introduction to the subject, as the author writes with smoothness and simplicity and has sandwiched his science so well with mythology and history that it is easily assimilated. Unfortunately, there is little material to give either incentive or assistance to actual observation. The satisfied reader will be definitely an armchair astronomer.

The text is divided into five parts. Two of these deal with the zodiacal and 12 other constellations; one discusses the sun and the moon; one, the planets; and the last considers other celestial phenomena including comets and meteors.

Each topic is treated independently in a short section which gives the mythological story in full detail. Following this are a few paragraphs about associated astronomical events and discoveries, and some simple explanatory material for the budding scientist. The prominent features of the subject are mentioned and the observer is told where and when to look for them, but it is doubtful if he would recognize many of these celestial objects without more definite instructions.

A simple drawing of the mythological figure and a chart of the principal stars accompany each constellation chapter. Stars are sometimes referred to by their names and sometimes by their Greek letters, but the latter are not shown on the charts. There are also charts of the sky for the four seasons, but they are so indistinct as to be useless as aids in observing.

The appendix consists of 24 illustrations in halftone which include views of Lick Observatory and copies of celestial photographs made at Yerkes and Mount Wilson.

HAZEL BOYD
Amateur Astronomers Ass'n.
New York City

PRACTICAL MARINE NAVIGATION

James A. Stowell. Addison-Wesley Press, Inc., Cambridge, Mass., 1944. 133 pages. $2.50.

NAVIGATION is here presented from the purely practical standpoint as well as from what should be called the fundamental standpoint (some would call it "old-fashioned" rather than fundamental).

The author is a master mariner, and originally designed the material in mimeographed form for use in teaching classes, presumably of "boys of average high school age possessing only very average mathematical skills." By means of this material, the author cut in half the actual classroom time necessary to complete the course in the two branches of the science, Geo- and Celo-navigation, as Mr. Stowell calls them. Nevertheless, it is the long way around which he advocates—all solutions are by trigonometry, and Sumner lines are computed by the cosine-haversine method.

The student who is taught by this book will have little knowledge of the modern flourishes and short methods which have taken practically all the "pain" out of teaching navigation in a hurry to service men already overburdened with practical science as applied in every phase of military action. But it must be admitted that the student who has not reviewed the material in

Some Harvard Observatory Publications

The Universe of Stars — 1929 edition of a series of radio talks by Harvard astronomers; in four parts on the Material of Astronomy, the Solar System, Stars and Nebulae, the Stellar Universe. 198 pages, including an index; illustrated $1.25

The History and Work of the Harvard Observatory — 1839 to 1927. By Solon I. Bailey. An outline of the origin, development, and researches of the Astronomical Observatory of Harvard College, together with brief biographies of its leading members. 301 pages, including subject index and name index. Published in 1931 ..... $2.50

Tercentenary Papers of the Harvard Observatory — Vol. 105 of Harvard Annals, 1937. Thirty-four papers on current astronomical researches at Harvard. Astrophysics, meteoric astronomy, photometry, and the problems of stellar distribution, variable stars, and external galaxies are about ecually represented. Numerous plates, tables, diagrams, and subject bibliographies. 632 pages $4.00

History and Bibliography of the Light Variations of Variable Stars; supplementary volume containing the stars recognized to be variable during the years 1931-1938. By Richard Prager. This Vol. 111 of Harvard Annals, 1941, supplements the earlier variable-star surveys with which the author was long associated at the Berlin-Babelsberg Observatory. 251 pages $4.00

All prices are postpaid — send your remittance with order.

Harvard College Observatory 60 Garden Street Cambridge 38, Mass.

"A DROP OF INK MAY MAKE A MILLION THINK"

Astronomers will want to read "Rockets—New Trail to Empire." Blazing the trail into tomorrow; where the Astronomer should reign Supreme! $2.00 the copy.

UNITED STATES ROCKET SOCIETY, INC.
Box 29, Glen Ellyn, Ill.

Introductory
ASTRONOMY
By J. B. Sidgwick
Foreword by Dr. Clyde Fisher

Fascinating summary of modern astronomical knowledge. Illustrated with 47 star maps, a lunar map and 4 maps showing the constellations of each season. "Clear, practical, dependable." —*Natural History*

$2.50

Philosophical Library, *Publishers*, 15 E. 40th St., N. Y.

FUN IN THE DARK
250 LUMINOUS STARS
Moon & 4 Planets
For ceiling of your Den, Bar, Rumpus Room or Bedroom. Have your own Planetarium.
They shine with outdoor realism AFTER turning off lights.
Gummed and Ready to Put Up
Only $2.00 postpaid
Complete with Chart and Directions
"STARS" • 12,200 BLIX STREET
NORTH HOLLYWOOD CALIF

Ready Soon!

OPTICAL INSTRUMENTS

By Earle B. Brown

Foreword by James G. Baker of Harvard Observatory

This book fulfills the need for a volume thoroughly covering the general field of optical instruments. It discloses the basic principles of design and function, with considerable emphasis on the telescope, binoculars, the spectroscope, and range finders.

The first of four parts covers completely the principles of geometrical optics; then there is a discussion of the operation and theory of optical instruments. The third part covers the construction and maintenance of both optical and mechanical parts of instruments of all kinds. In the fourth part such supplementary topics as the manufacture of optical glass, mathematical proofs, and a glossary of terms, are included. There is an adequate index.

432 pages—Fully illustrated—$10.00

Send for a copy on 10-day approval.

Handling charges are extra unless remittance accompanies order; C.O.D. orders accepted; include 40 cents extra on orders outside U. S. and remit in U. S. funds.

CHEMICAL PUBLISHING CO. Inc.
26 Court St., Dept. ST Brooklyn 2, N. Y.

Practical Marine Navigation cannot be considered a master of his subject—he would find many gaps in his training as a navigator were these not filled in by the mechanical and tabular aids almost sure to be at his command in military practice.

If you are one of those who wants to learn his navigation "a la Bowditch," then here is a working manual which will help considerably in your study, especially if you are going to be a self-taught navigator. Definitions commence the book; then come chapters on the compass and its errors, on trigonometry and the sailings, of which the treatment is unusually extensive. More definitions then introduce celestial navigation, and some very practical diagrams for consideration of altitude corrections, latitude, time, and longitude, add considerably to the value of these chapters. "Longitude by Time Sight Method" heads a chapter which is followed by the usual line-of-position problems. A chapter on star identification and one on spherographical navigation (the newest shortcut for aviators) conclude the book.

"Full and By" is an epilogue in which the author states "short-cuts and rounding corners have no place in the primary classes." His own unbiased reasons and his acknowledgment of the value of other methods leaves one thinking that perhaps a return to fundamentals is indicated now that the greatest rush in training men to navigate is over.

C.A.F.

NEW BOOKS RECEIVED

Nicholas Copernicus: A Tribute of Nations, *Stephen P. Mizwa*, editor, 1945, *Kosciuszko Foundation*. 268 pages. Special edition, $5.00.

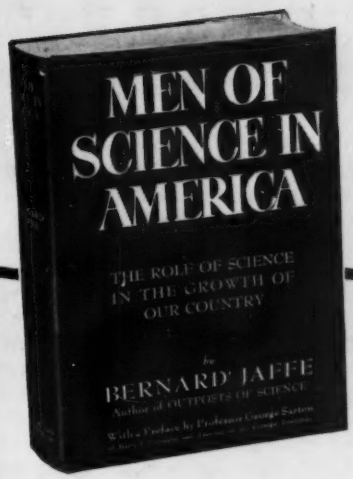
This is an illustrated book commemorative of the recent Copernican quadricentennial. Texts of speeches and tributes, reports on radio programs, exhibits, and special celebrations, lists of participating institutions, publications, and societies, make up a comprehensive review of the worldwide tribute paid to Copernicus in 1943, especially in May of that year, which marked the 400th anniversary of his death.

Astronomical Navigation Without Mathematics, *A. L. Miéville*, 1945, *Macmillan*. 25 pages. 65 cents.

A simple, step-by-step analysis of the reasoning involved in making it possible to navigate by the stars. The text purposely avoids all references to any but a fundamental method for position finding, and the method is developed with elementary text material and the use of diagrams. For readers to whom the very fundamental principles of navigation are not known or not clear.

The Elements Rage, *Frank W. Lane*, 1945, *Country Life, Ltd.*, London. 188 pages. 10s. 6d.

A book about the "violent manifestations of Nature" in which some of the chapter headings are: Hurricanes, Waterspouts, Lightning, Meteorites, Volcanoes. Illustrated with a number of striking action photographs, the text is entirely non-technical, and includes many unusual anecdotes.



"Ought to be read by scientist and non-scientist alike"
—*The Scientific Monthly*

"A series of lively personal sketches and a useful, rapid picture of what is going on in such fields as general physics, genetics, astronomy and atomic research." —*The New Republic*

"Mr. Jaffe gives us more than a series of penetrating biographies. We have not only pictures of exceptional scientists in action, but a history of science in biographical form. Though the men selected were not aware of their social importance, they influenced society profoundly. This social note vibrates through the book, and stands as an example of the way biographies should be written."
—*Book-of-the-Month Club News*

"A pioneer in an important field. Mr. Jaffe has succeeded in stating an outline of American science and in describing its continuities and interrelationships, and is, so far as I know, the first historian who has ever done so. He has written a book which has long been needed."
—*New York Herald Tribune*

Professor George Sarton of Harvard has written the foreword. The book contains 600 pages, 28 plates, and 25 text diagrams. Third printing.

Price $3.75

SIMON AND SCHUSTER, Publishers

OBSERVER'S PAGE

All times mentioned on the Observer's Page are Eastern war time.

Comet Pons-Winnecke Returns on Schedule

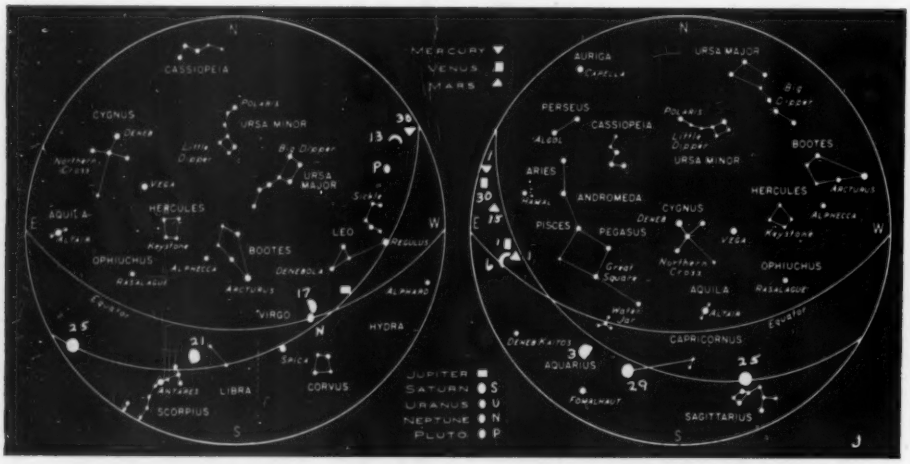
HENRY GICLAS, of Lowell Observatory, observed the famous Pons-Winnecke comet early in May, not far from the position predicted on the basis of previous returns of this comet, which was first discovered by Pons at Marseilles in 1819. In a telegram received at the Harvard College Observatory on May 10th, Dr. V. M. Slipher, director of Lowell Observatory, stated that on May 3rd Mr. Giclas had observed the comet at right ascension $12^h\ 59^m.5$, declination $+45°\ 22'.1$, which is in the constellation of Canes Venatici. It was of the 14th magnitude, and its daily motion was 53 seconds west and 10 minutes of arc south.

In 1939, at its previous return, the comet and the earth were at a minimum distance apart of about 11 million miles, and the comet appeared of the 9th magnitude. The current closest approach will probably find at least 38 million miles between us and the comet, so it is doubtful if it will reach a brightness sufficient to make it easy to find in amateur telescopes.

In addition, the perihelion distance of the comet has been steadily increasing since its discovery. In 1819 it passed the sun at 72 million miles, in 1909 at 90 million, and its 1945 perihelion, about July 8th, is expected to be approximately 108 million miles. This increase in the size of its orbit is the result of gravitational perturbations by Jupiter, which has a period about twice that of the comet, so that at each alternate revolution the comet passes rather close to the giant planet.

The **Handbook** of the British Astronomical Association gives an ephemeris of predicted positions for Pons-Winnecke this year, that on May 3rd being given as $13^h\ 16^m$, $+45°\ 26'$. Those possessing large telescopes may wish to write the editor of **Sky and Telescope** for copies of the ephemeris.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 4:30 a.m. on the 7th of the month, and at 3:30 a.m. on the 23rd. At the left is the sky for 10:30 p.m. on the 7th and for 9:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury passes from the morning to the evening sky on the 15th, setting in twilight about an hour after the sun by the end of the month.

Venus, in the morning sky in Pisces and Aries, will be at greatest elongation west, 45° 46', on June 24th, when it is about 25° above the eastern horizon at sunrise.

Earth will arrive at heliocentric longitude 270° at 2:52 p.m., June 21st, with the sun in Gemini. Summer will begin in the Northern Hemisphere, and winter in the Southern.

Mars, in Pisces and Aries, is in the morning sky. It will reach magnitude 1.1 at the end of the month.

Jupiter is in Leo, and sets at midnight about the middle of the month.

Saturn and **Uranus** are too near the sun to be of interest for night observing. On June 11th, Saturn will be occulted by the moon at midday, for observers in Canada and our more northerly states, but as the moon will be about 1½ days old, this will be a very difficult event to observe.

Neptune, in Virgo, will cease its retrograde motion on June 15th. See diagram in the January issue.

By Jesse A. Fitzpatrick

AN ASTEROID AND TWO PLANETS

Upon receiving my April number of **Sky and Telescope**, I looked up the position of Vesta for April 5th in Webb's **Atlas of the Stars**, and checked the star positions by means of Norton's **Star Atlas**, using the data from the table of Vesta's positions in the magazine.

Almost immediately I discovered with a pair of 10x binoculars three stars in the vicinity of Sigma Virginis, where the atlases gave only two. To find out which was Norton's star "64" and which was Vesta, I went out again on April 6th, stated to be the night of Vesta's opposition, and discovered that Vesta was between 64 and Sigma, moving toward Sigma.

By looking slightly to the side of Sigma away from Vesta, I was able to see the asteroid clearly out of the corner of my eye, as well as star 64 farther away. There is another star in that region near 64 which seems of approximately magnitude 6.6; I got one good glimpse of it, as well.

Next I observed the other side of the sky, and discovered Uranus, on his path toward a position south of Tau in Taurus. This planet, too, was visible to the naked eye, if one looked in the region long enough. It would come and fade in irregular manner, as did the two stars that are about the same distance from Tau as was Uranus.

Finally, on the same evening, I located Neptune in the precise spot indicated in your January issue. With my glasses it was extremely faint, but unmistakably present.

Thank you for the data about Vesta, which enabled me to view my first asteroid, and with the naked eye at that.

STEPHEN H. FORBES
842 Mt. Pleasant Road
Bryn Mawr, Pa.

AN ASTRONOMER'S LOT

A letter from a West Coast amateur to Leon Campbell, recorder of the A.A.V.S.O., discloses an unusual but rather dire predicament into which an ardent amateur may fall. He opens his letter by outlining his resolution to make an ever-increasing number of variable star observations, but goes on to say: "However, the other night I had a little talk with two policemen in the lot where my observing is done.

"It seems as though several nights ago a cafe which has its rear door opening on this lot was entered and robbed. Quite naturally the police were as thick as flies for a while. Well, these two wanted me to prove that I was on that lot just for the sake of observing. I did not have much trouble proving to them that I was observing variables, but they told me that the F.B.I. had been patrolling the area quite extensively lately. They told me it would be very wise for me to get a letter or some

OCCULTATIONS—JUNE, 1945

Local station, lat. 40° 48′.6, long. 4h 55m.8 west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
June 2	6.5	29 Aquarii	3:32.4 a.m.	66°	4:51.3 a.m.	255°
19	6.9	BD —5° 3762	11:45.7 p.m.	154°		
20	6.6	BD —6° 3887	0:28.1 a.m.	159°		
22	6.7	BD —14° 4188	2:22.6 a.m.	31°		
27	5.9	17 Capricorni	11:52.1 p.m.	92°	1:07.1 a.m. (28)	253°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

means of proof from the one I'm working for. . . . They also informed me that they are clamping down on people with high-power telescopes, and that if the F.B.I. men had been there instead of them, they would no doubt have confiscated the telescope and locked me up for a while. . . ."

Indeed, an observer's lot is not always a happy one.

T PYXIDIS SUBSIDES

Since the discovery of the re-outburst of Nova Pyxidis (see page 15 in the May issue), observations, both visual and photographic, made at Kirkwood, Cordoba, and Harvard observatories, indicate that the nova has steadily decreased in brightness from magnitude 10.8 early in April to 11.4 by April 20th. This confirms the indication given by a Mount Wilson spectrogram obtained April 4th (the time of discovery of the increased brightness) that the nova was already past maximum brightness. The spectrogram contained the so-called coronal and forbidden lines usually found in the post-maximum stages of nova development. On previous occasions this recurring nova reached the 7th magnitude at maximum.

PHASES OF THE MOON

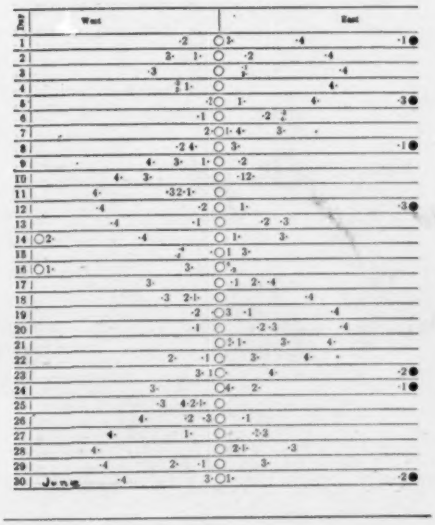
Last quarter .....June 3, 9:15 a.m.
New moon .....June 10, 0:26 a.m.
First quarter .....June 17, 10:05 a.m.
Full moon .....June 25, 11:08 a.m.

JUPITER'S SATELLITES

On June 10th and 24th, the four principal moons will be west of the primary, and on June 20th they will be on the east side. On the 10th, they will be in numerical order outward from Jupiter.

Moon IV will reappear after occultation on June 15th at 11:13 p.m.

Jupiter's four bright moons have the positions shown below at 11:45 p.m. on the day preceding the date shown. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the **American Ephemeris and Nautical Almanac.**



RETURN TO AN OBSERVATORY

Many amateur observatories have of necessity been temporarily abandoned these days—gas is scarce and everyone is busy with war work. L. S. Copeland, of Santa Barbara, Cal., who compiles Deep-Sky Wonders each month, and whose observatory narrowly escaped destruction in a forest fire in 1940, writes: "On February 10th I revisited our mountains. Lizards were asleep under the wheels of the starhouse roof; a centipede crawled out. Not for 15 months had the roof been rolled back. At first it would move only about three inches, and no farther. But when I pushed upward, I was able to break the "time" lock. Yet not before the bushes outside had been trimmed could the roof be rolled off. Also, rats had eaten up half of the oilcloth cover on the telescope. Reminds me of Rip's return.

"I saw Iota Orionis. It is a double in its own right, as well as near an opera-glass double (see your back cover picture of Orion, January, 1945). I had forgotten how it looked."

Sky Publications

Relativity 50c

The astronomical implications of the general theory uniquely described in the language of the intelligent layman. By Philipp Frank, of Harvard University.

400-Year Calendar 10c

Find any date from 1600 to 2000 in a jiffy; in two colors; small size; send 3c postage.

Splendors of the Sky . . . 25c

36 pages of beautiful photos of every type of celestial body; wonderful for children. This is a revised edition, containing many new illustrations. Send 3c postage. In lots of a dozen, $2.75, plus postage.

THE BOOK CORNER

Hayden Planetarium - New York 24, N. Y.

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium, 81st Street and Central Park West, New York City, and of the Buhl Planetarium, Federal and West Ohio Streets, Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents, *June 1st through 27th*, STARS OVER PITTSBURGH.

Summer evenings are ideal for making friends with the stars, and this sky show is designed to be an easy introduction to the beautiful constellations which shine during the summer months. You will hear some of the star stories the ancients told, and see some of the old constellation pictures magically appearing in the planetarium sky.

Beginning *June 28th*, PREVIEW OF THE JULY ECLIPSE. A solar eclipse is without doubt the most startling event that ever happens in the sky. This preview in the planetarium heavens of the July 9th eclipse will show visitors what to look for, and explain the celestial mechanism responsible for blackouts of the sun.

★ **THE HAYDEN PLANETARIUM** presents in *June*, THE SUN AND ECLIPSES. (See page 3.)

In *July*, SUMMER STARS. Warm weather and vacation periods combine to make the beautiful nights of summer the perfect time for stargazers. In the Hayden Planetarium during July you can quickly and easily learn the major summer constellations—Scorpius, with its bright-red star; Sagittarius, with its tea-kettle figure; the Northern Cross, and others. Learn the simple guide-lines to help you find your way from one constellation to another.

★ SCHEDULE BUHL PLANETARIUM

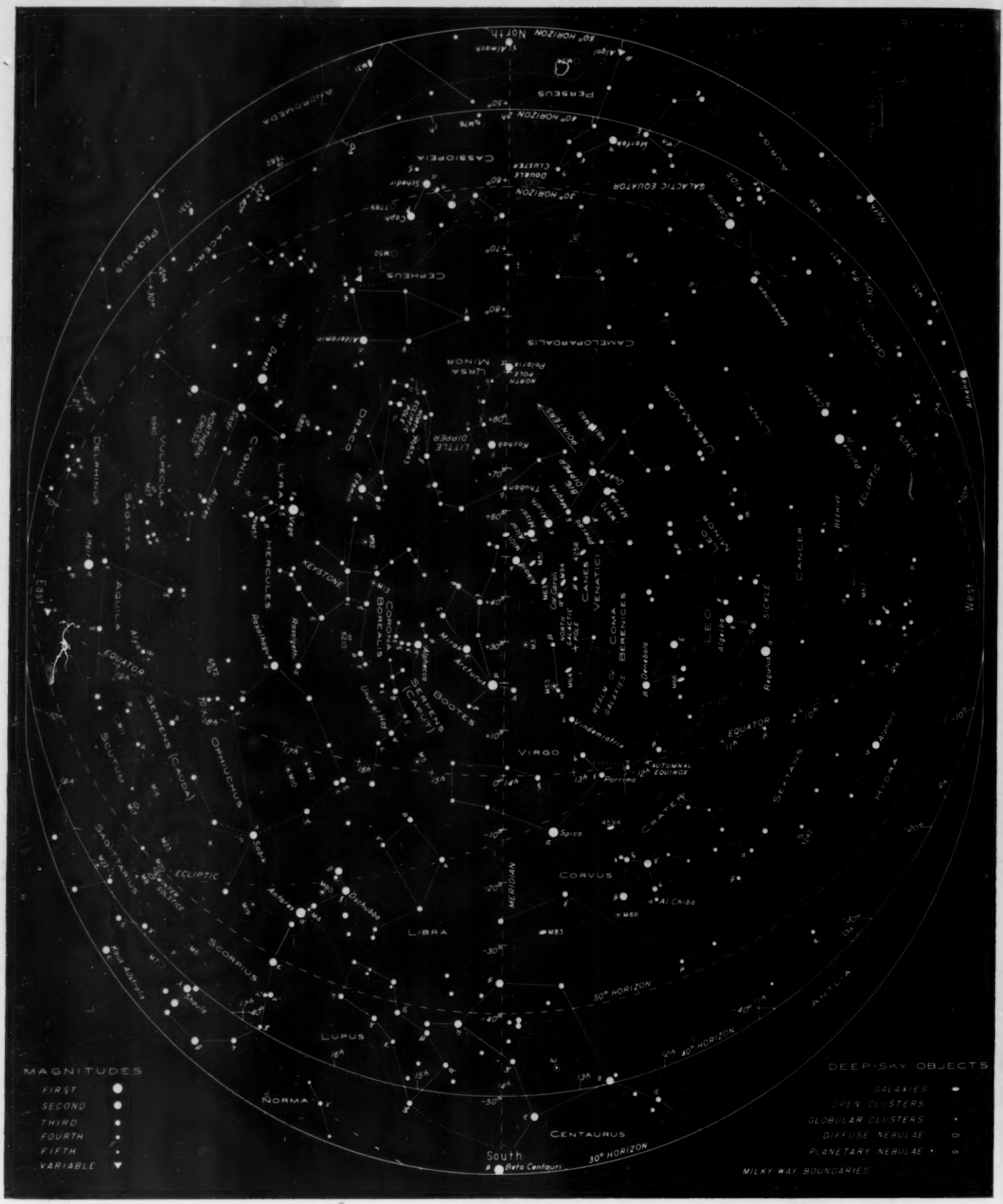
Mondays through Saturdays ..... 3 and 8:30 p.m.
Sundays and Holidays ..... 3, 4, and 8:30 p.m.

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, John F. Landis; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays ..... 2, 3:30, and 8:30 p.m.
Saturdays ..... 11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays ..... 2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles; *Scientific Assistant*, Fred Raiser; *Lecturers*, Catharine E. Barry, Shirley I. Gale, John Saunders, Robert Snedigar.



DEEP-SKY WONDERS

AMONG marvels for observation in June skies are the objects listed here, some of which are not shown on the chart above. The informal descriptions are for common telescopes. Norton designations are in parentheses.

Corvus. NGC 4361 (65′), 12h 20m.4, —18° 20′; planetary. In amateur telescopes, small fuzzy oval, with center like a dim star.

Leo. NGC 3521 (13′), 11h 3m.2, +0° 14′; small galaxy at Lion's hind feet.

Coma Berenices. M85 or NGC 4382, 12h 22m.8, +18° 28′; elliptical galaxy. Dim, fluffy. NGC 4565 (24′), 12h 33m.9, +26° 16′; galaxy. Biggest northern edge-on, dim but handsome in large amateur telescopes.

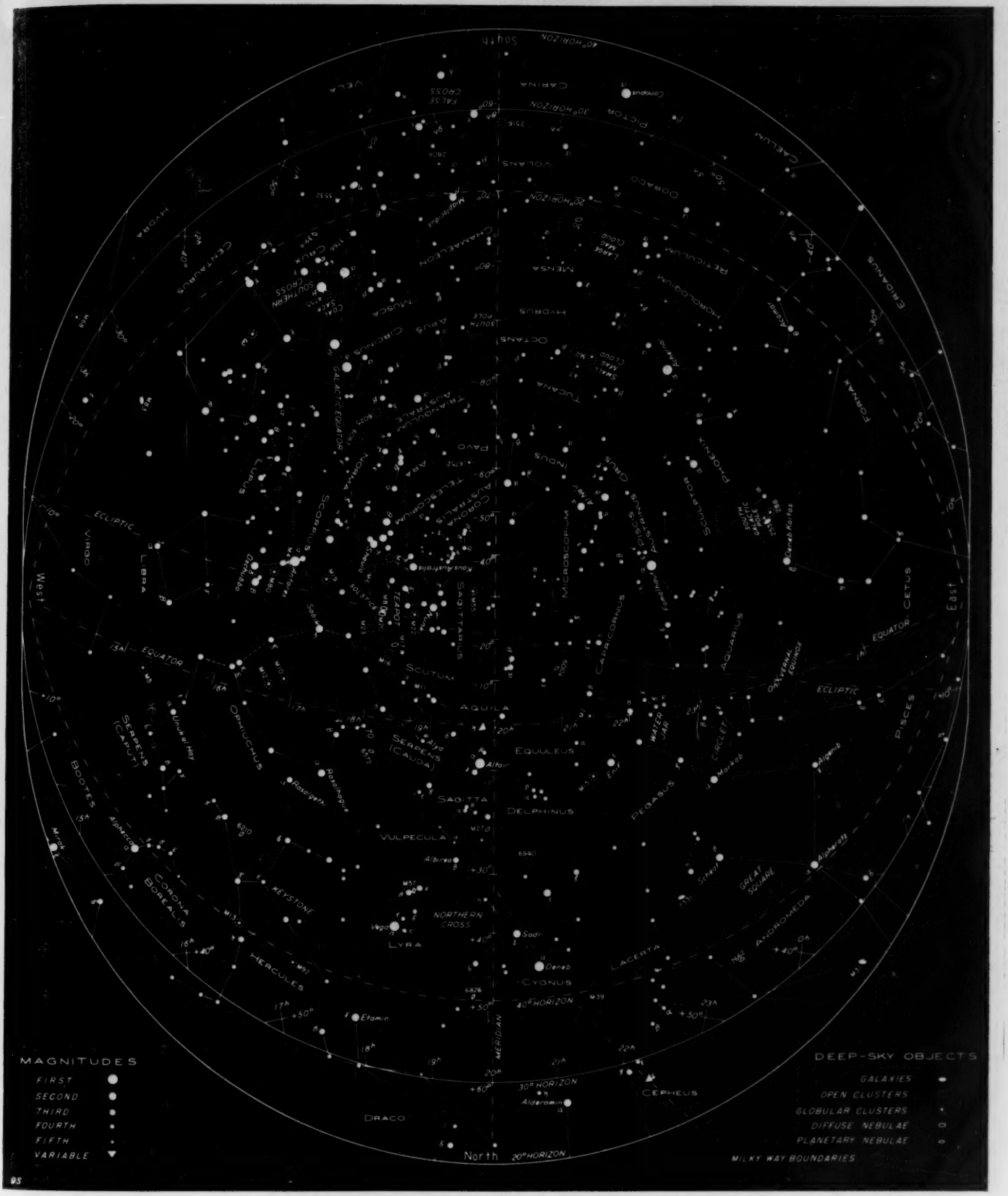
Scorpius. M4 or NGC 6121, 16h 20m.3, —26° 24′; large globular, near Antares.

Hercules. NGC 6210, 16h 42m, +23° 54′; planetary. Oval, light blue, very small.

L. S. COPELAND

STARS FOR JUNE

from latitudes 30° to 50° north, at 10 p.m. and 9 p.m., war time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.



EVENING STARS FOR SOUTHERN OBSERVERS

THIS is the sixth map in the series of star charts for use by observers in the Southern Hemisphere, and matching the northern maps. It is prepared for a basic latitude of 30° south, but may be used conveniently 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. When 12 charts have been produced, and if interest warrants, a special edition of **Sky and Telescope** may be published each month carrying observing material for Southern Hemisphere observers. This chart is for use in latitudes 20° to 40° south on August 7th at 11 p.m., August 23rd at 10 p.m., Sept. 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly: four minutes earlier per day. These are local mean times which must be corrected for standard time and war time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts.

Not Salvage---
Not Rejects---Not Junk!

Each piece guaranteed a gem of beautiful optical and mechanical workmanship. Nothing just like this material has ever before been offered to amateurs. Our prices are a small fraction of original costs. Limited supply available of items listed.

ORDER NOW—DON'T BE SORRY!

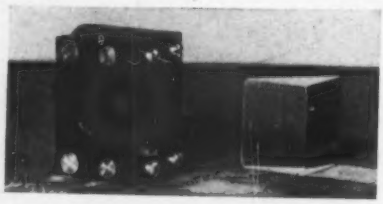
EYEPIECE IN FOCUSING MOUNT, 1⅜" (35 mm) f.l. Surplus lot from war instrument. Tremendously wide field of view. Diameter of eye lens more than 1", field lens 1¼". All outside lens surfaces fluoride coated. Most remarkably efficient (brilliant) eyepiece ever. Each $4.50. Bushing to fit standard 1¼" telescope tube $3.00 extra. Bushing to fit your special tube size $4.00 extra.

DOUBLE ACHROMATIC LENS SYSTEM. All outside surfaces fluoride coated; 2½" (64 mm) f.l. Mounted, o.d. 1 3/16" (30 mm). Clear aperture 7/8" (23 mm). Suitable for inverter with the above eyepiece, as an excellent magnifier of 4 power and as a projection lens for Kodachrome slides size 2x2....Each $3.50

ACHROMATIC CEMENTED OBJECTIVE, 1⅞" (48 mm) diameter, 10½" (264 mm) f.l., not mounted, fluoride coated. .....Each $3.00

MIRRORS: Front surface aluminized 1⅞" x 2" (irregular), 1/16" thick. Each 25c

PRISMS: Excellent optical surfaces and very close angle tolerances, 1"x 1⅛" face. For smaller reflectors.....Each $2.35
Size 2½"x 2½" prism, unmounted, white optical glass, excellent optical quality, slight edge imperfections. Each $7.50



Also the following prisms in metal mountings, ready to make into diagonals, fluoride coated, meet the most exacting requirements, corrected to 2 seconds of arc: 9/16" (15 mm) x 11/16" (18 mm) $2.00 (suitable for micro projection). 1 1/16" (27 mm) x 1 3/16" (30 mm) $3.00; and 1 5/16" (34 mm) x 1¼" (33 mm) $3.50 (these two sizes are suitable for 6" and 8" diameter reflectors). Also: Amici roof prism, double inverting, guaranteed corrected to 2 seconds of arc, 13/16" (21 mm) x 13/16". Each $2.00

Include Postage—Remit with Order

CATALOG of lenses, prisms, etc. Send 10c

HARRY ROSS

Scientific and Laboratory Apparatus
70 W. Broadway, N. Y. 7, N. Y.

GLEANINGS FOR A.T.M.s

MAKING YOUR OWN TELESCOPE

From Start to Finish—8

By ALLYN J. THOMPSON

Spider Support. Drill a ¼" center hole through a block of hardwood, 1.7" square, and 1½" long, and saw it out in the shape shown in Fig. 29. For the vanes cut four rectangular pieces, 1½" x 2¾", from sheet metal not less than .012" thick, and attach them with small wood screws to the wooden form. Holes for attaching the spider to the tube must be drilled in the vanes so that they will be equidistant from the rotational axis of the diagonal, and in a plane at right angles to it. This can be done accurately on the lathe, or a special jig must be made for locating them. Fig. 30 shows such a setup. The spider

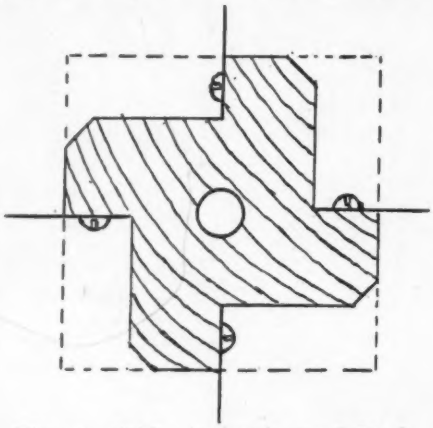


Fig. 29. Spider support: wood block to which vanes are attached.

rotates on a piece of ¼" rod set in blocks, so that each vane will land in turn on a board from which the point of a nail protrudes. A light tap with a mallet or stick will impress the nail point in the vane. Trim the vanes to a triangular shape, as in Fig. 27.

Threading is cut for ⅝" on four ⅞" lengths of ¼" rod. The unthreaded end is slotted with a hacksaw for ⅜" lengthwise, and a hole is drilled into it, across the slot. In lieu of cutting and threading the rod, 1" long ¼-20 bolts, with the heads sawed off, can be used. These studs are attached to the vanes with cotter pins, to hold the spider in the tube. The holes in the tube should be about 9/32" in diameter, located exactly in the same plane, and so placed that the spider will assume the position in Fig. 31, thereby giving access to the diagonal adjustment screw.

The inside of the telescope tube, adapter tube, vanes, and all other exposed parts should be thoroughly blackened. The mirror and diagonal can now be aluminized.

Saddle. Since the eyepiece of the Newtonian reflector is frequently found to be in an awkward position for observing, it is customary to provide a

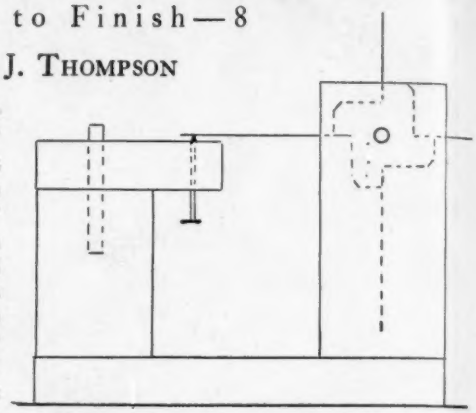


Fig. 30. Jig for aligning holes in vanes in same plane.

means for rotating the tube in its saddle, or cradle (Fig. 1). A good length for the saddle is 15" to 18". The tube rests in V ways, or the ways may be curved to fit the tube. The center of balance of the telescope must be centered on the saddle, and, to prevent slipping, two rings of metal, wood, or thick leather belting are secured to the tube, flanking the ways. Straps hold the telescope to the saddle. A method of attaching bolts to the straps is shown in Fig. 32. The end of the strap is riveted between two metal plates, to which the bolt is also riveted. This bolt enters a slotted metal bar screwed to the bottom of the saddle, and extending about an inch on either side (Fig. 1). To reduce friction in rotating, line the under sides of the straps, and the ways, with strips of felt. This material can be glued in place. With such an arrangement rotation is easy, and when it is time to close up for the night, the straps can be quickly slipped off and the telescope removed indoors.

Collimation. Strap the tube in its saddle and clamp that to the workbench so it cannot shift. Set up a lamp or other light source about 48" from the

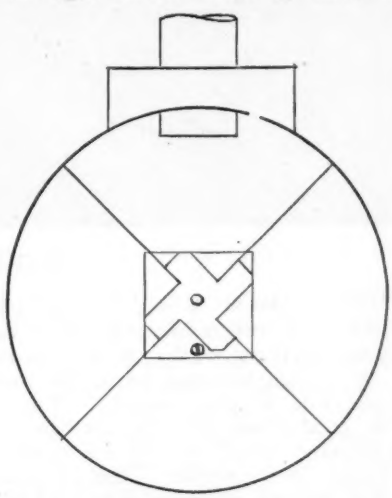


Fig. 31. Position of spider in the telescope tube.

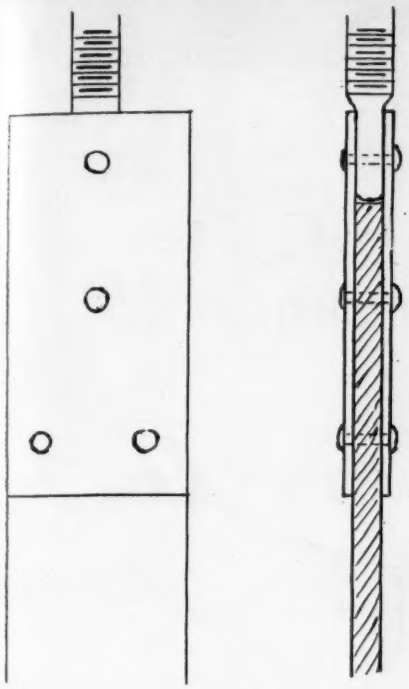


Fig. 32. Joining bolts to leather (or metal) straps for holding telescope to saddle. (See Figs. 1, 39, and 43.) Ends of bolts and straps are riveted between two thin metal plates.

eyepiece end of the tube, and stand a white cardboard screen having a ⅛" hole in it directly before the lamp. Make two cardboard disks, each having a ⅛" centered hole, and fit one into each end of the tube. By sighting through the holes, adjust screen and lamp to bring all three holes in line. A wooden plug with a ⅛" center hole snould be fitted into each end of the adapter tube and a length of ⅛" rod inserted through each of these plugs. Square the rod exactly with the tube lengthwise, by means of the adjustments on the blocks, then push it in until it has gone past the center of the tube. See if the rod has cut off the light by sighting through the tube. If not, adjust the adapter until the light is completely blocked off, then square the rod lengthwise again, as this first adjustment will probably have been disturbed. Repeat until certain the adapter is square in both planes. Remove the rod and plugs, and the disk at that end of the tube. Put in the spider, and center it by sighting through the tube. Put in the mirror. An image of the ⅛" hole in the screen will probably be found on the screen, and, by manipulating the adjusting nuts on the mirror cell, make this image fall directly back upon the hole. The axes of the mirror and tube are now coincident, and at right angles to the axis of the adapter.

All that remains is to insert the diagonal, at a 45° angle, and to bring the deflected axis of the mirror coincident with the axis of the adapter. Fix a diaphragm of some material, having a 1/16" hole in its center, over the eyepiece end of the adapter. Look through this opening, and you will see the walls of the adapter tube, a reflection of the mirror in the diagonal and in this a reflection of the spider, also a reflection of the hole in the diaphragm through which you are peering. These reflections must all be brought concentric with each other, and if the preliminary work has been carefully done, the three adjustments on the diagonal will be sufficient for the purpose. This last operation is most easily performed outdoors, with the telescope pointed at the daylight sky.

The Finder. Usually attached to the reflecting telescope is a small refractor, of short focal length and low power, and possessing a wide angular field of view. For a 6-inch telescope, the finder may be anywhere from 1" to 2" in aperture, and 6" to 12" in focal length. When it is aligned axially with the larger telescope, the finding of a celestial object is made easy by reason of the large field of the finder.

Crosshairs of wires are usually stretched diametrically in front of the field lens of the finder eyepiece, exactly in the focal plane of the combination, and intersecting at right angles in the center of the field of view. When the two telescopes are aligned axially, an object at the intersection of the finder crosshairs is also in the center of the field of the principal instrument.

While the finder is at times a convenience, it is not at all necessary on a telescope of the size we are making, especially if setting circles are to be

ASTRONOMICAL TELESCOPES, BINOCULARS, CAMERAS, MICROSCOPES, BOOKS
Bought, Sold, Repaired
We have Some Fine Bargains in Used Instruments
RASMUSSEN & REECE
41 Market St., Amsterdam, N. Y.

EVERYTHING for the AMATEUR
Telescope Maker
Precision Workmanship. Quality Supplies. Money Back Guarantee
KITS—OUR SPECIALTY
COMPLETE 6" KIT $4.00
PYREX KIT, 6" 5.50
Other Sizes, Proportionately Low
PYREX MIRRORS
Made to order, correctly figured, polished, parabolized and aluminized.
ALUMINIZING
We guarantee a Superior Reflecting Surface, Optically Correct Finish. Will not peel or blister. Low prices.
MIRRORS TESTED FREE
PRISMS—EYEPIECES—ACCESSORIES
FREE CATALOG:
Telescopes, Microscopes, Binoculars, etc.
Instruction for Telescope Making 10c
Precision Optical Supply Co.
1001 East 163rd St. New York, N. Y.

RAMSDEN EYEPIECES
Designed for Astronomical Telescopes ¼", ½", 1", 2" Focal Lengths, 1¼" Diam.
Each..$7.50 Set of Four..$28.00
FIRST QUALITY RIGHT ANGLE PRISMS
⅛", $3.50; 1", $5.00; 1¼", $6.50; 1½", $8.00
ACHROMATIC LENSES, MIRRORS, TO ORDER
TINSLEY LABORATORIES
Berkeley 4, Calif.

FOR SALE
5-inch Equatorial Refractor
Clock-driven—Finder—8 Eyepieces
This fine telescope, 75 inches focal length, is in excellent condition. Its tube is of heavy aluminum; the mounting is of heavy castings, on 8-inch iron pipe with large flange base. Setting circles in both R.A. and Dec.; slow motion in R.A.; synchronous motor drive. If desired, the 12-foot wooden observatory with revolving dome and slit may also be purchased.
The owner of this instrument was a well-known amateur astronomer who made regular observations with it until his recent death; his total investment in this observatory was $2,500. Purchaser must cover packing and shipping charges from Redding.
Reasonable offers requested.
Mrs. L. B. Goldhorn Redding, Conn.

Custom Built Optical Elements
Achromatic Telescope Objectives
Fluoride Hard Coated Made to Order. Precision Annealed Glass Used Exclusively:

Aperture	Focal Length	Price
2-inch	20 inches	$15.00
3-inch	30 "	30.00
3-inch	45 "	40.00
3½-inch	45 "	60.00
4-inch	60 "	100.00
4½-inch	60 "	150.00
5-inch	75 "	200.00
6-inch	90 "	400.00

The above objectives are NOT *mounted.*

★

Pyrex Telescope Mirrors Made to Your Order. Correctly Figured — Aluminized :

Diameter	Focal Length	Price
4-inch	32 inches	$15.00
6-inch	50 "	40.00
8-inch	64 "	70.00
10-inch	80 "	100.00
12-inch	96 "	200.00

Above focal lengths are subject to tolerances of plus or minus 2½%

★

Optical elements available and ready for delivery; Achromats

Diameter	Focal Length	Price
36 mm.	180 mm.	$2.00
20 mm.	95 "	2.00
18 mm.	95 "	2.00

Send for Free List
MAYFLOR PRODUCTS CORP.
Katonah 3, N. Y.

attached to the mounting. It is strictly an encumbrance on a portable instrument, where a pair of sights will serve equally well. These need not be gunsights, but any protruberances on the tube that will be of aid in aiming it precisely at an object.

IX—MAGNIFICATION; EYEPIECES; FIELD OF VIEW

Magnification. This is the effect of increasing the apparent angular size of an object. In Fig. 33a a distant object D has an angular size at the eye equal to angle a. If its distance is reduced by half, the angular size of the object is doubled, and it appears twice as large.

In the case of very near objects, the aid of a convex lens or magnifying glass, of suitable focal length, must be resorted to. In Fig. 33b, an object O, distant about 10 inches (taken to be the distance of best vision) from the eye, subtends there the angle a, in this case 4°. For closer inspection it is placed one inch from the eye, Fig. 33c. Of course, the eye cannot focus on so near an object, so a convex lens of 1″ focal length is introduced, which produces an enlarged virtual image of the object at O′. This enlarged image subtends the larger angle a′, and the ratio of a′ to a is equal to the magnification. It follows, therefore, that the magnifying power of any single lens, or combination of lenses used as a simple microscope, is equal to 10/f, where f is the focal length (or equivalent focal length) of the lens in inches.

In Fig. 33d an image of a distant object is formed at I, by the objective lens L. The angular size of the object at L (or at the eye, since for very distant objects the difference is negligible) is equal to angle a. The image I is enlarged by the eyepiece E so that it has the apparent angular size a′. Therefore the ratio of angle a′ to angle a is equal to the magnification; it is easily seen that the magnifying power of any telescope is thus equal to F/f, where F is the focal length of the objective (or mirror) and f is the focal length of the eyepiece.

Eyepieces. Astronomical oculars, having large apparent fields, are of two types, the Huygenian and the Ramsden. Both are mounted in standard tubing of 1¼″ outside diameter, and are made in equivalent focal lengths, commonly, from 1½″ down to ¼″.

In the Huygenian ocular (Fig. 34a), which is composed of two plano-convex lenses with the convex surfaces facing away from the eye, the focal plane lies between the components, so it cannot be used as a simple magnifier, and for this reason is called a negative ocular. Spherical aberration is not eliminated in this type, so it does not perform as well as the Ramsden on telescopes of moderate or short focal ratios. In the usual design of the Huygenian, the focal lengths of the field and eye lenses are in a ratio of 3 to 1, with a separation of half the sum of the focal lengths. Thus, in an eyepiece of 1″ equivalent focal length, the focal lengths of the field and eye lenses are 2″ and 2/3″ respectively. Their separation is 1 1/3″, measuring between the convex surfaces.

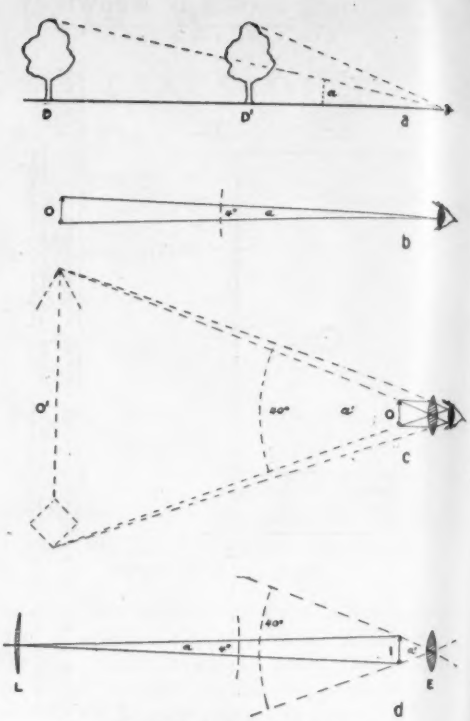


Fig. 33. Illustrating angular magnification.

In the Ramsden, or positive ocular (Fig. 34b), the field and eye lenses are usually of equal focal lengths, with the convex surfaces facing each other, and separated by a distance equal to 2/3 of their focal length. Thus, in an eyepiece of 1″ e.f.l., the focal length of the lenses will be about 1 1/3″, with a separation of .9″. This ocular has a good flat field, about 40° in extent, and is superior to the Huygenian for work on reflecting telescopes, which are usually of short or moderate focal lengths. While not fully corrected for color, this defect is not troublesome, inasmuch as the reflector itself is achromatic.

A modification of the Ramsden ocular, in which the eye lens is formed of an achromatic combination of crown and flint glass, called the Kellner (Fig. 34c), gives a flat, colorless field about 50° in extent, as large a field as can ordinarily be used. It is excellent in low powers, where its wide apparent field can be used to advantage in variable star work, comet seeking, and so forth.

Further notes and dimensions on eyepieces are given in **Sky and Telescope**, 28, 18, February, 1944.

(To be continued. Next month field of view concludes and discussion of the mounting begins.)

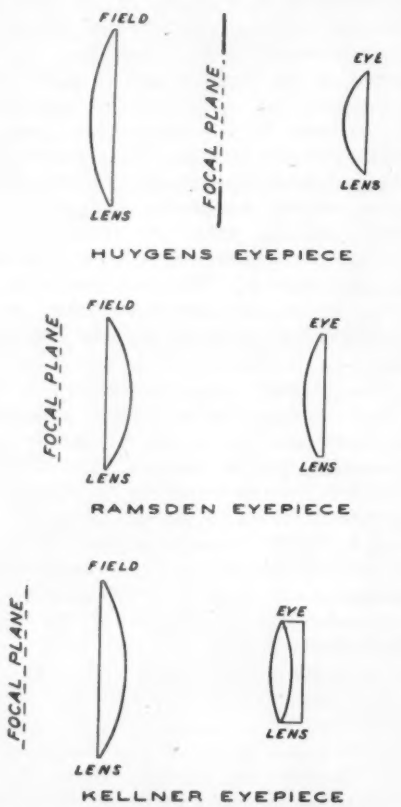


Fig. 34. a. Huygens eyepiece, with focal plane midway between the components, where a diaphragm excludes all but useful rays. b. Ramsden eyepiece, with focal plane about ¼″ in front of the field lens in a 1″ eyepiece. c. Kellner eyepiece, with focal plane about 0.4″ in front of the field lens.

1944 PITCH LAP

illustrates a quick, clean, easy way to make a perfect lap in ½ hour. Send $1 to

CHARLES A. SPICKLER
R. D., Yardley, Penna.

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

WANTED: Direct-vision spectroscope by Hicks or Zollner type; Herschel solar diagonal; Barlow lens; also eyepieces by Hastings, Clark, Gaertner, Fecker, Bausch & Lomb, and Dall or Old English. Give specifications and price. Address Box 14, Sky Publishing Corporation, Harvard Observatory, Cambridge 38, Mass.

FOR SALE: 6″ reflector. Splendid equatorial mount on tripod. R.A. and Dec. slow motions, finder and 3 eyepieces. Price $175.00. J. Milthaller, 1493 Montgomery Ave., New York 53, N. Y.

FOR SALE: 3″ x 45″ Bardou achromatic refractor; eyepieces 90x inverting, 45x erecting; altazimuth mounting with both table and floor tripods. $150.00. Sydney V. James, 521 Barry Ave., Chicago 14, Ill.

FOR SALE: 10″ pyrex unsilvered mirror, in excellent condition. Write James Bray, 860 Walnut Ave., Burlingame, Cal.

WANTED: 12″ or larger finished, pyrex, aluminized mirror. WANTED: rotating dome for observatory. E. P. Holleran, 12305 Turner, Detroit, Mich.

FORTY-FIVE years elapsed between Fraunhofer's discovery of the black lines in the solar spectrum and Kirchhoff's explanation of their significance. In 1859, Kirchhoff, professor of physics at Heidelberg, announced the mathematical deduction and experimental proof of the law which honors his name:

"The relation between the powers of emission and absorption for rays of the same wave-length is constant for all bodies at the same temperature."

From this knowledge of the cause of the black lines in the solar spectrum, Kirchhoff developed the theory that the sun was surrounded by a layer of vapors formed by the incandescent elements of the sun and that each vapor absorbed the rays emitted by its corresponding element. Thus was the actual composition of the sun revealed and thus was spectroscopic work given its greatest impetus.

Spectroscopy is still being given new refinements to make it more valuable in industrial, educational, and military research and quality-control. Perkin-Elmer is proud of its contributions of simplicity and versatility to this important work, through its new All-Purpose Infrared Spectrometer.

Similarly, Perkin-Elmer will bring to post-war analysis, control, inspection, and observation new refinements in other scientific optical instruments.

WHAT PERKIN-ELMER MAKES

Perkin-Elmer serves the optical sciences that broaden man's horizons by supplying them with:

Custom-built optical instruments for industrial analysis, control, and inspection.

New optical devices to solve specific problems, such as the all-purpose infrared spectrometer.

Special elements such as fine lenses, prisms, flats, photographic objectives, interferometer plates, retardation plates, Cornu prisms, Rochon prisms, Nicol prisms.

Perkin-Elmer is now 100% in war work, but after the war will resume manufacture of such peace-time products as Schmidt cameras, refracting and reflecting telescopes, equatorial mountings, oculars, direct-vision prisms, polarizing eye pieces, and other equipment.

THE PERKIN-ELMER CORPORATION

GLENBROOK · CONN·